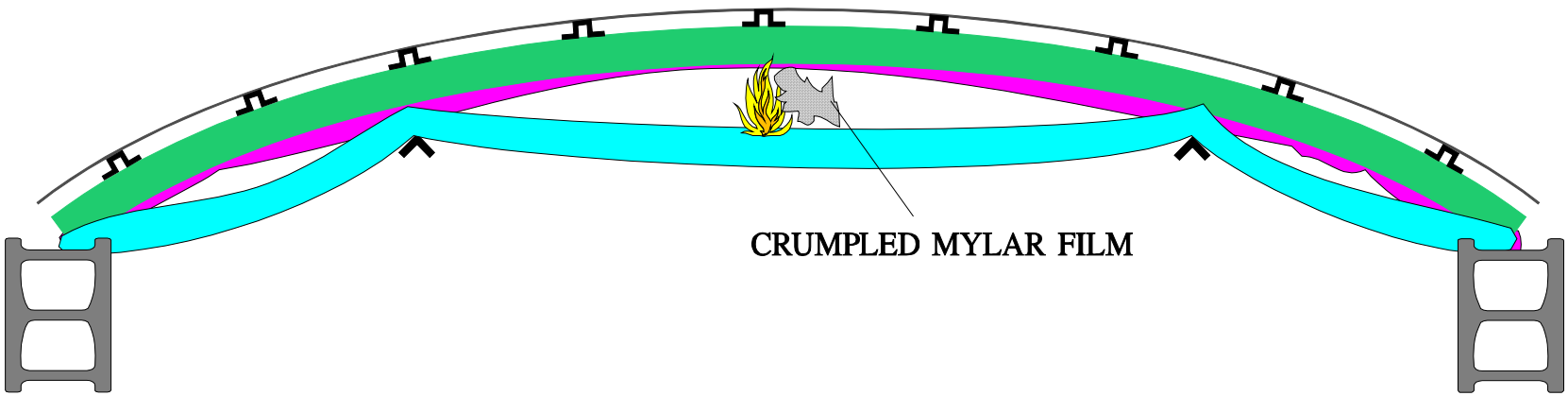
Thermal/Acoustic Insulation

Test Method Development

Small Tube Configuration

Initial Intermediate Scale Test Configuration



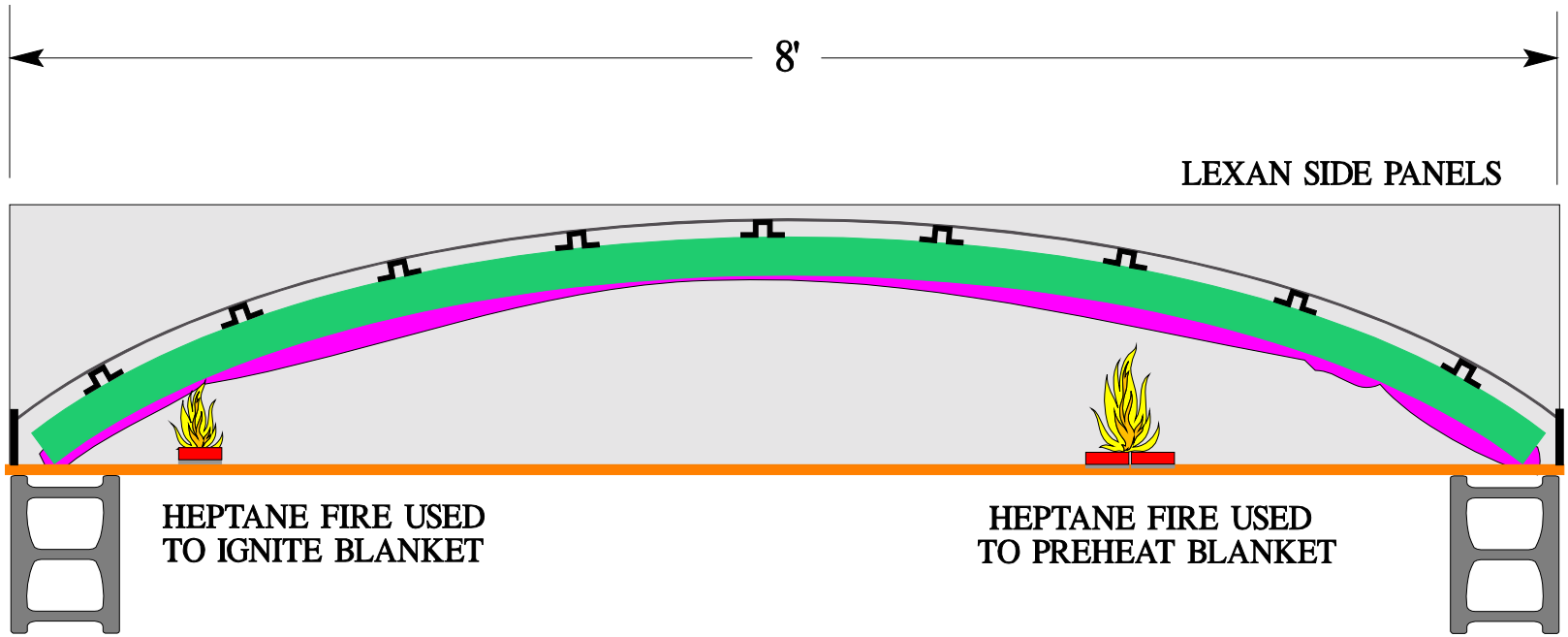
BETWEEN FRAME BLANKET

OVER FRAME BLANKET

EFFECT OF PRE-HEATING FILM

Initial Intermediate Scale Test Configuration

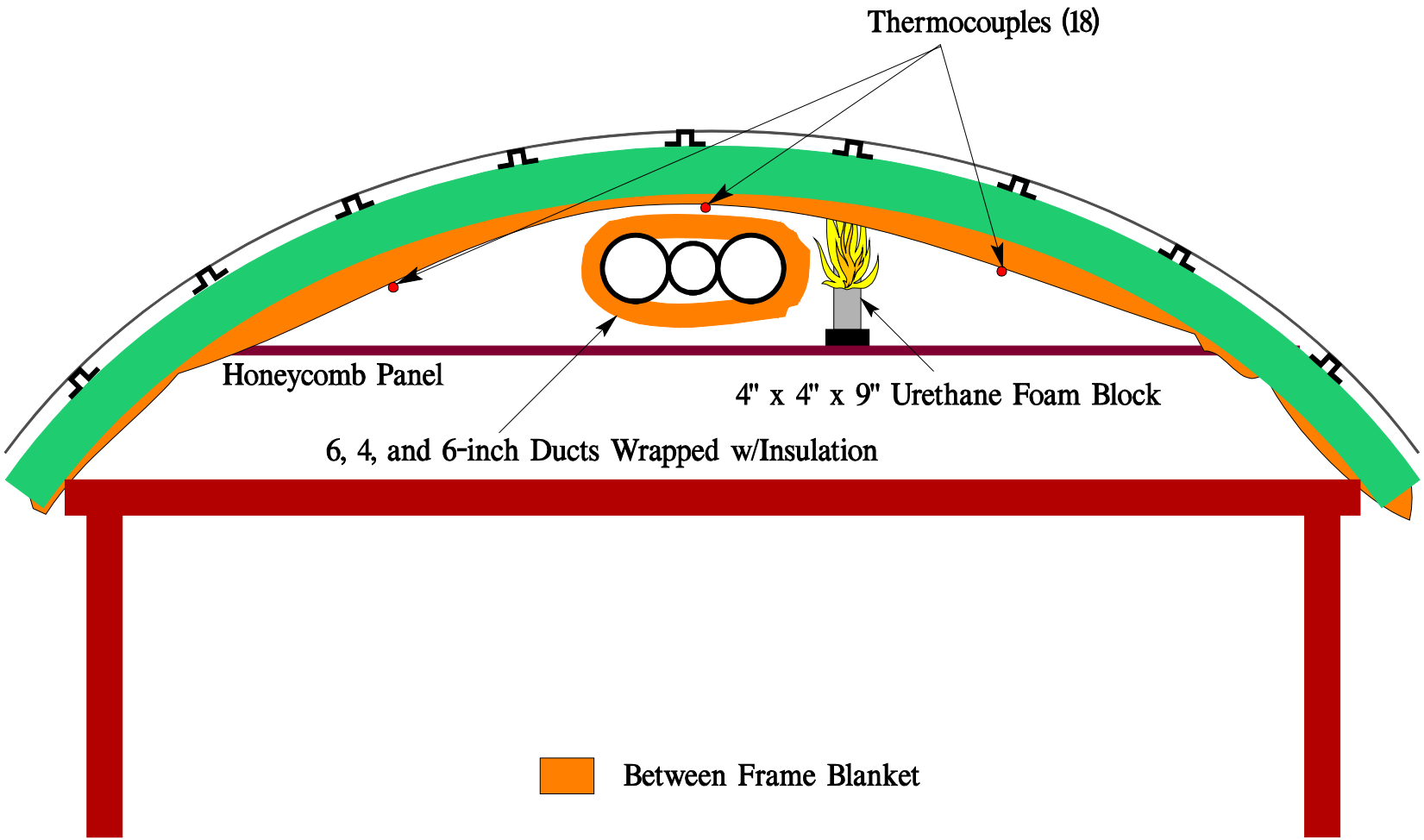
COMPARTMENTALIZED TEST



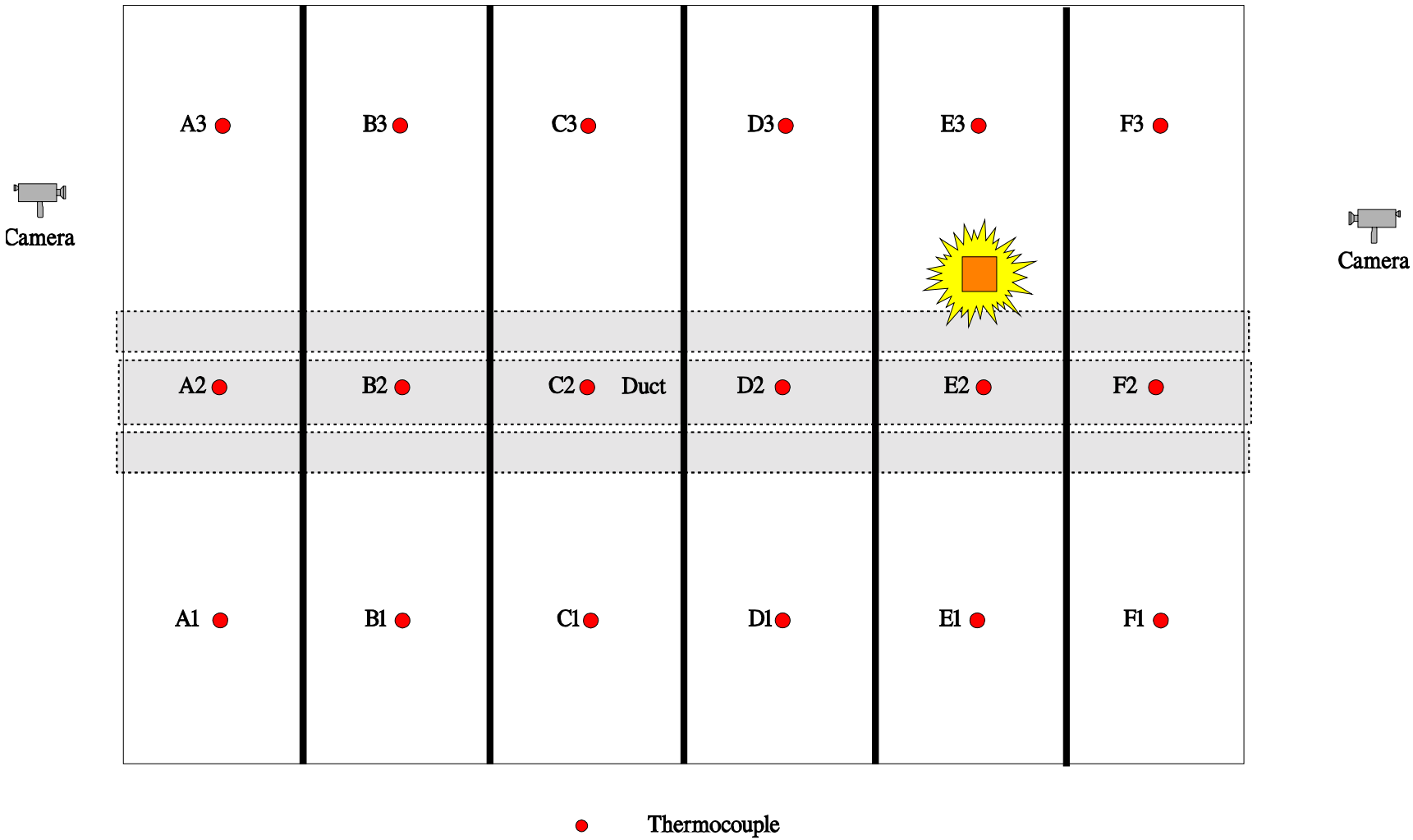
DC-10 FUSELAGE SECTION

INSULATION BLANKET

Intermediate Scale Flame Propagation Test Arrangement in 707

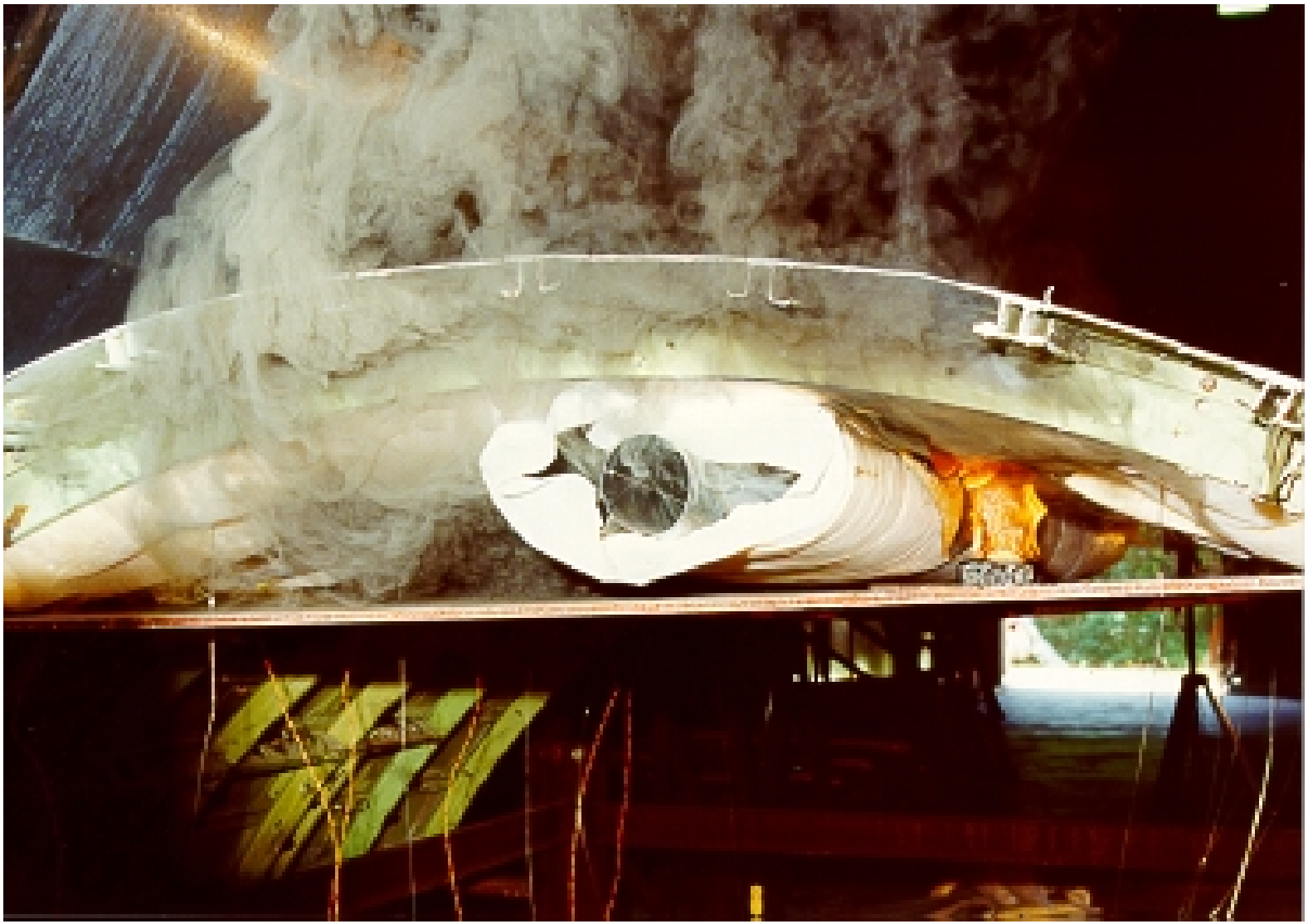


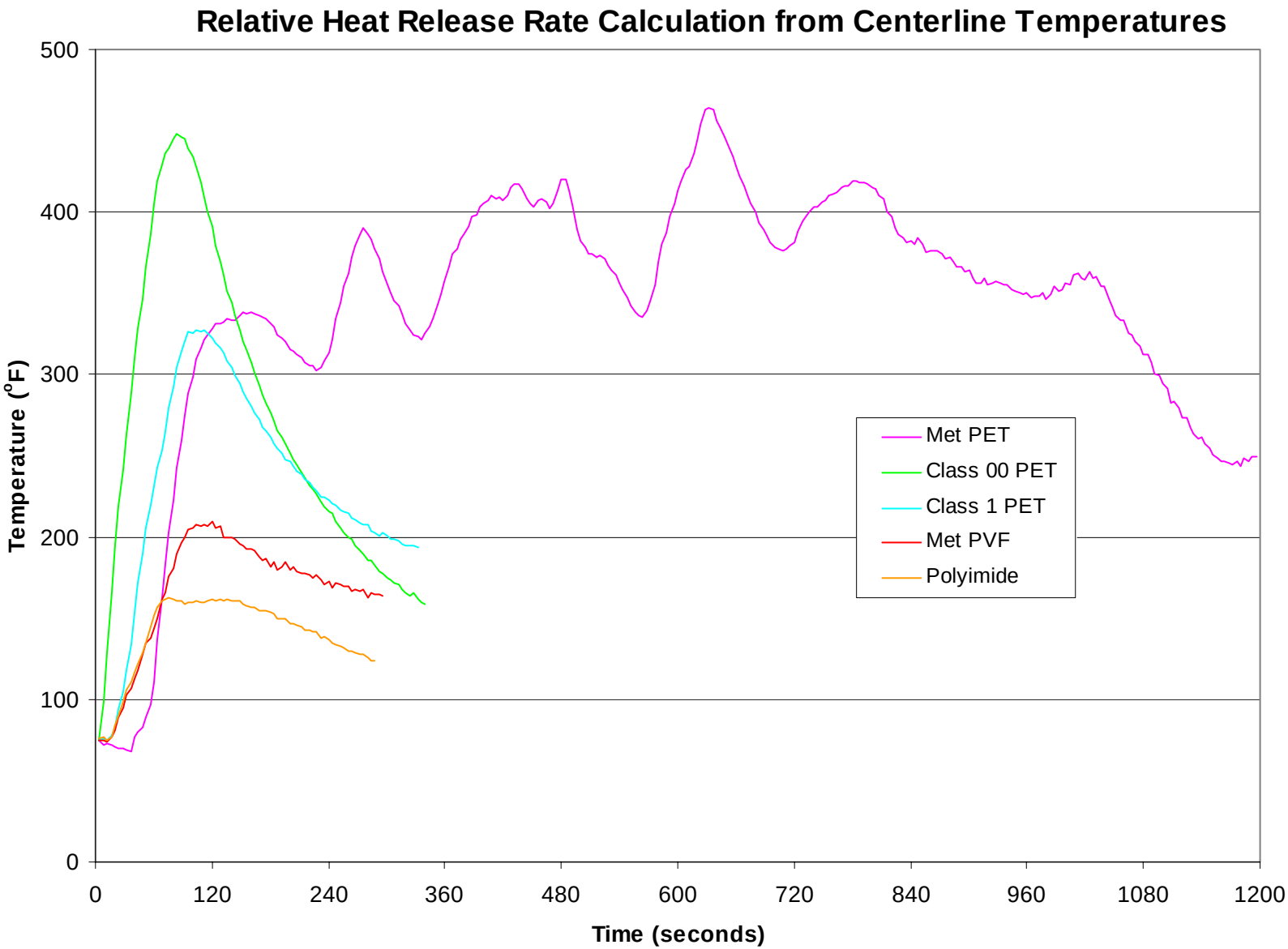
Intermediate Scale Flame Propagation Tests in 707 Overhead



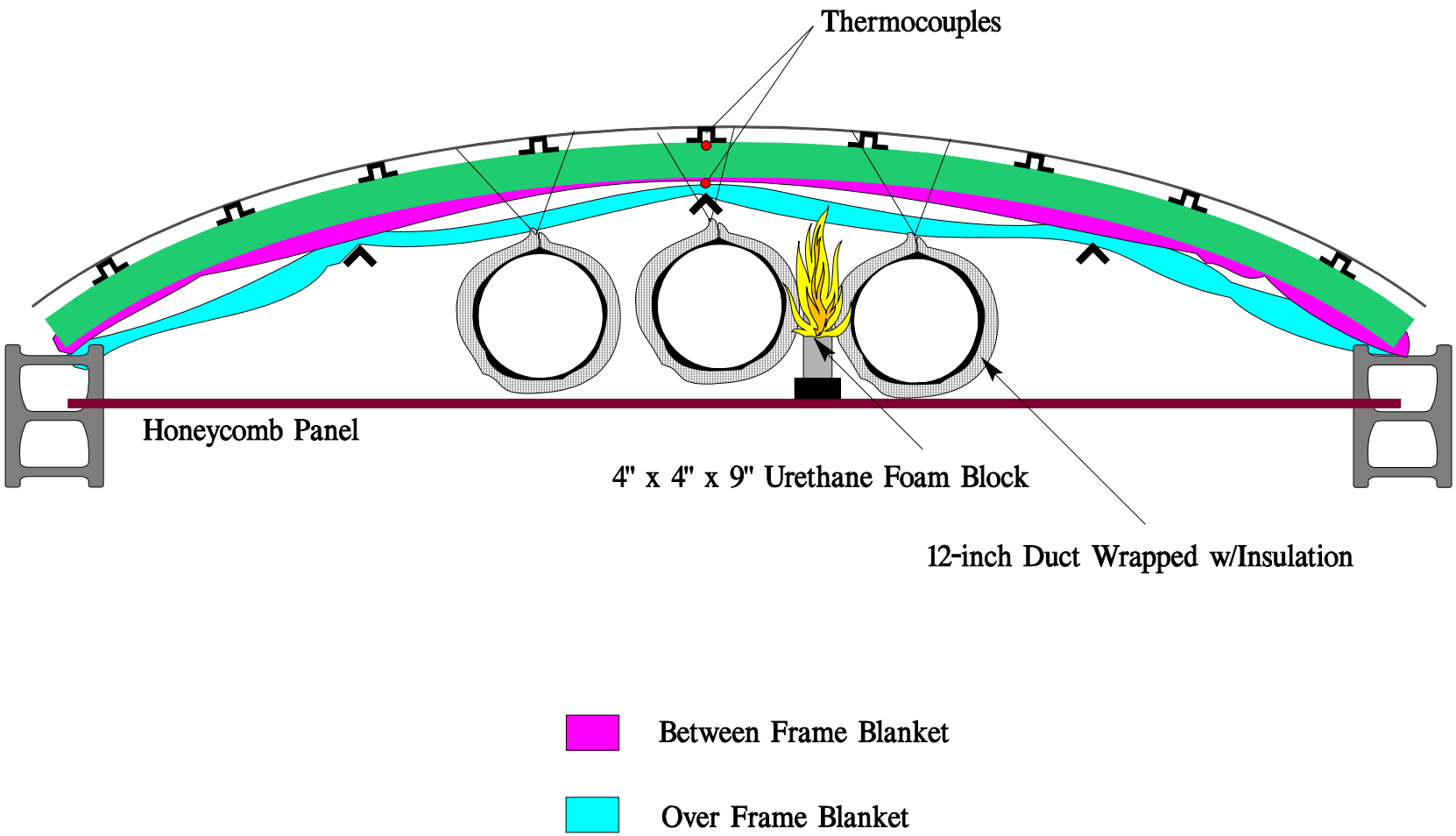
Metallized PET (2072K)

Class 1 PET

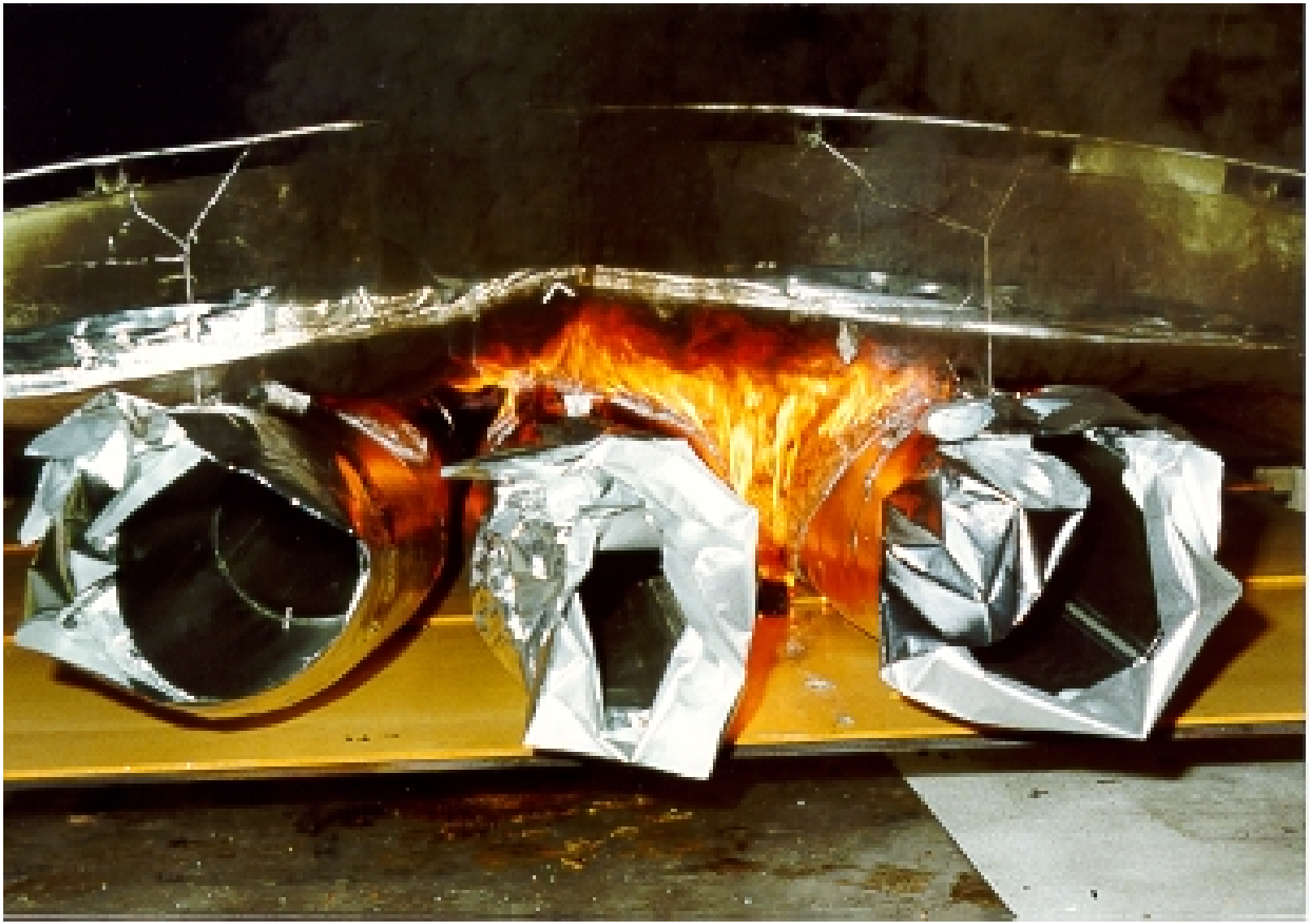



Relative Heat Release Rate Calculation from Centerline Temperatures
Temperature (°F)
500
400
300
200
100
0
0
120
240
360
480
600
720
840
960
1080
1200
Time (seconds)
Met PET
Class 00 PET
Class 1 PET
Met PVF
Polyimide

Intermediate Scale Flame Propagation Test Arrangement



Metallized PET (2072K)

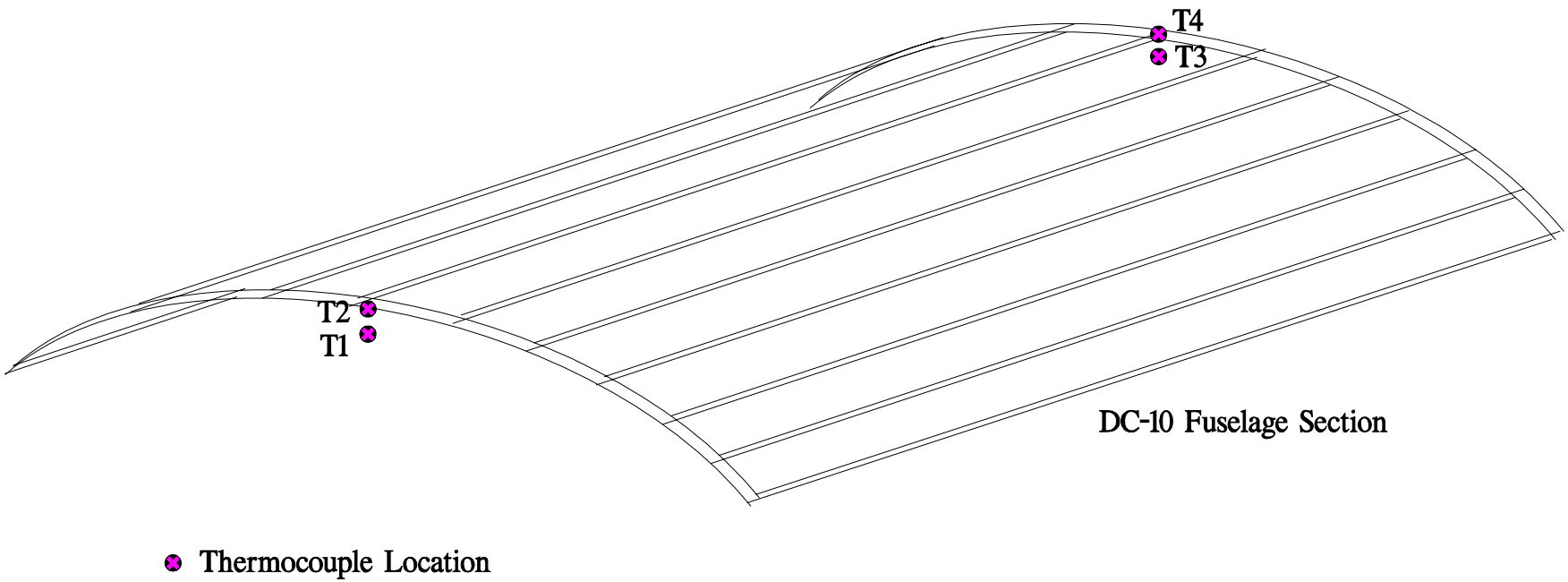


Metallized PET (2072K)

Polyimide Film

Polyimide Film, Post Test Damage

Energy Release Rate Determination

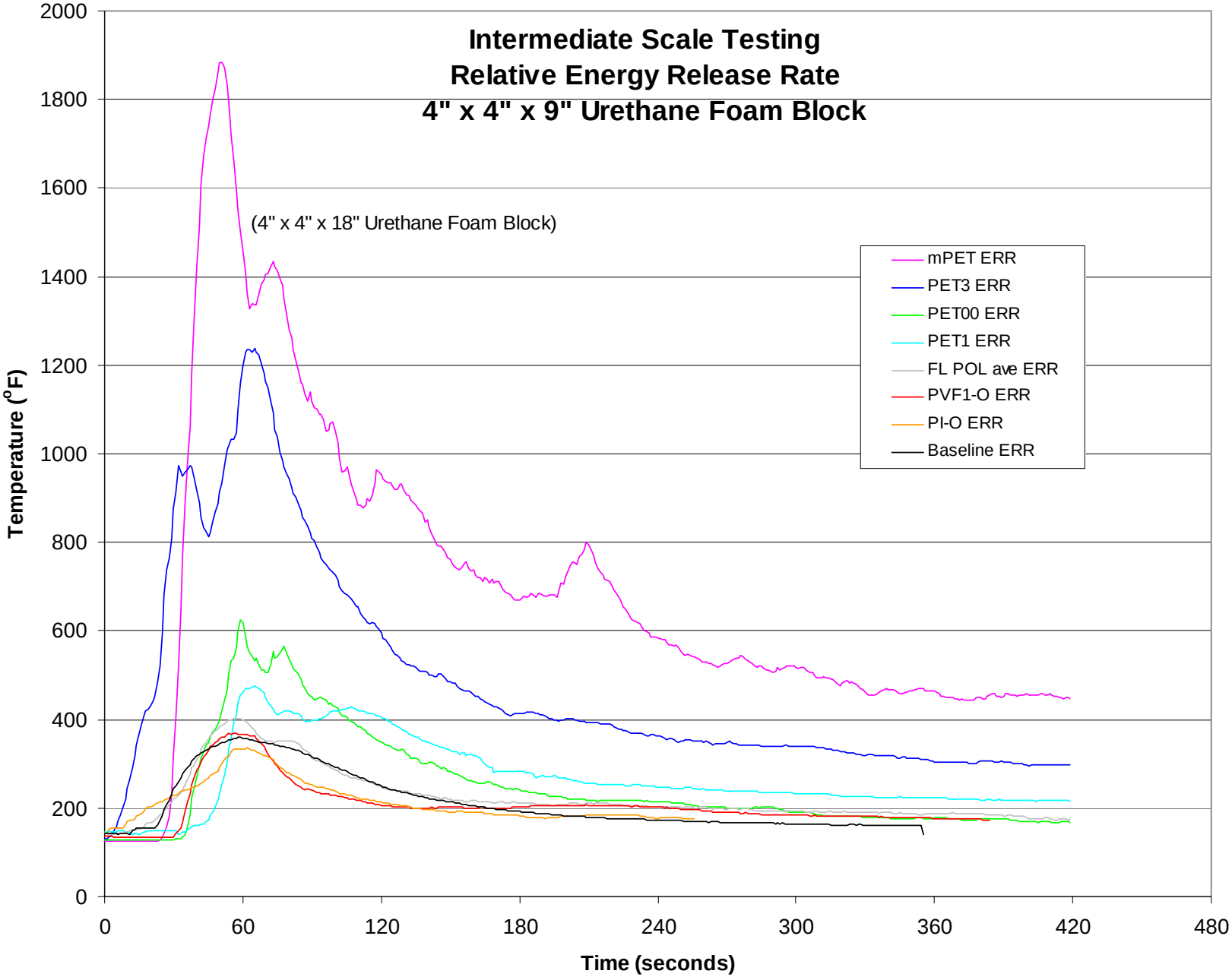


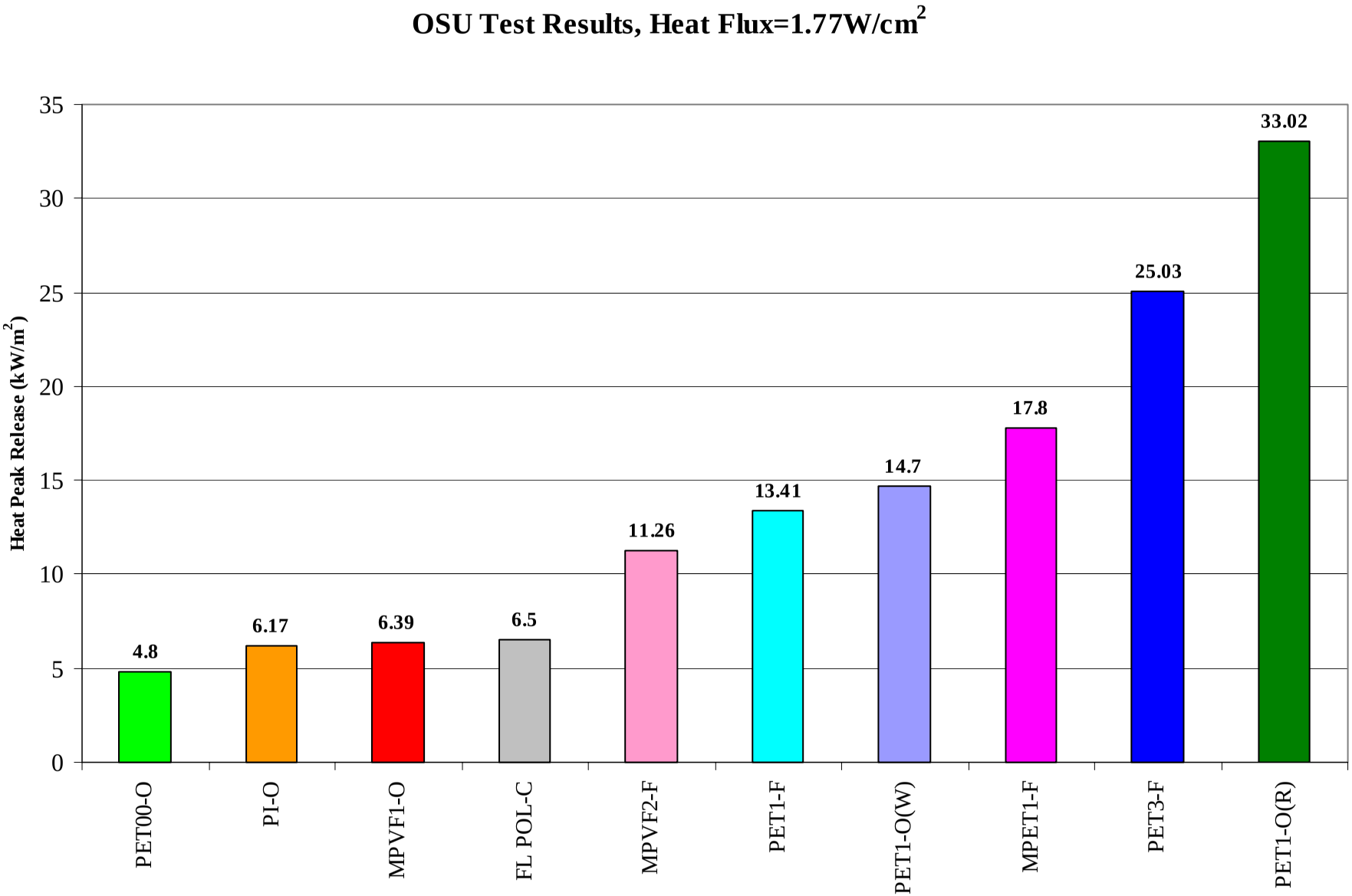
Energy Release Rate determined by:

Average of two thermocouples at each end, then the sum of the two end averages.

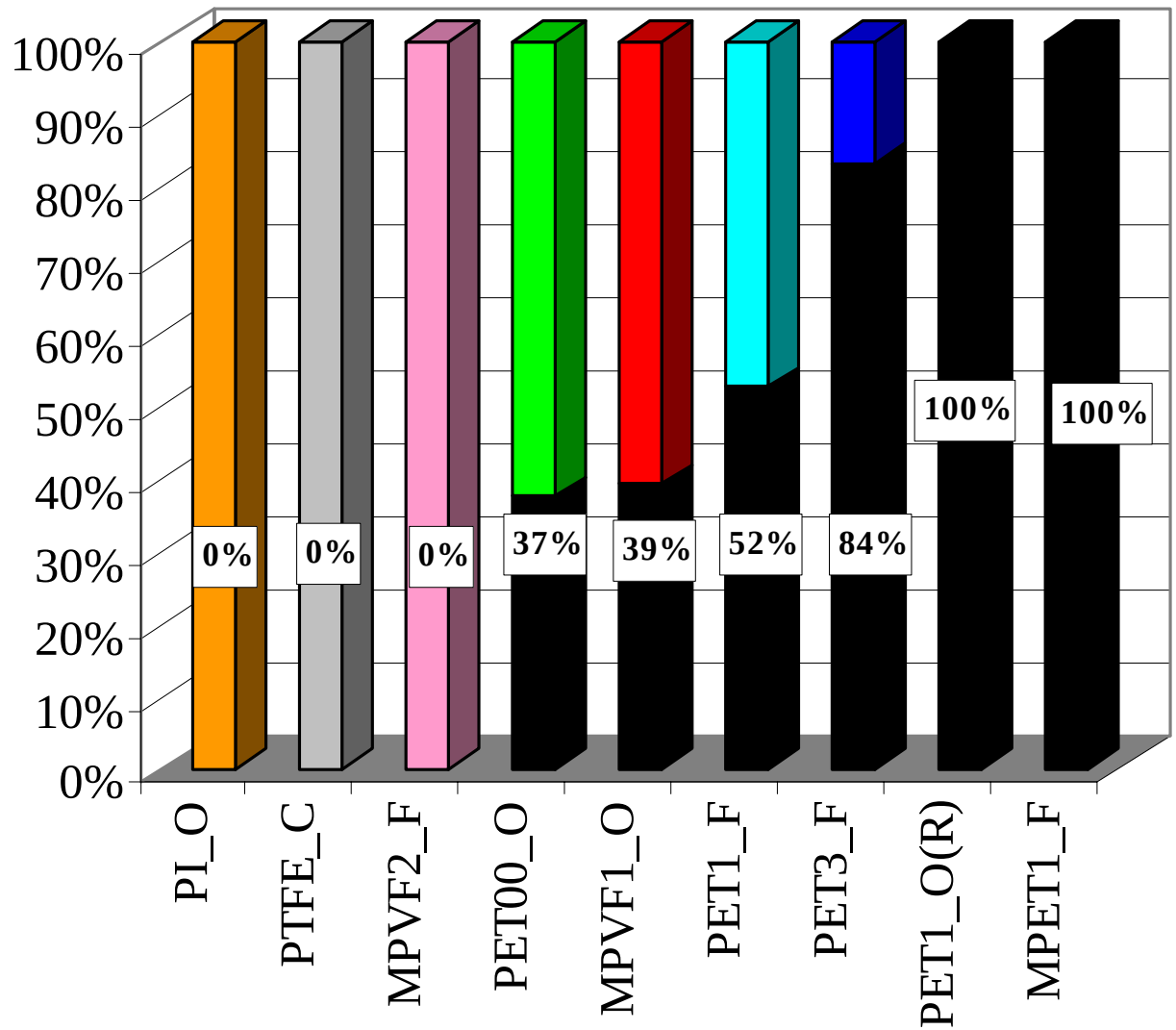
ERR=(T1+T2)/2 + (T3+T4)/2

If the mass flow rates are equal at both ends, then this procedure gives an approximation to the Energy Release Rate.

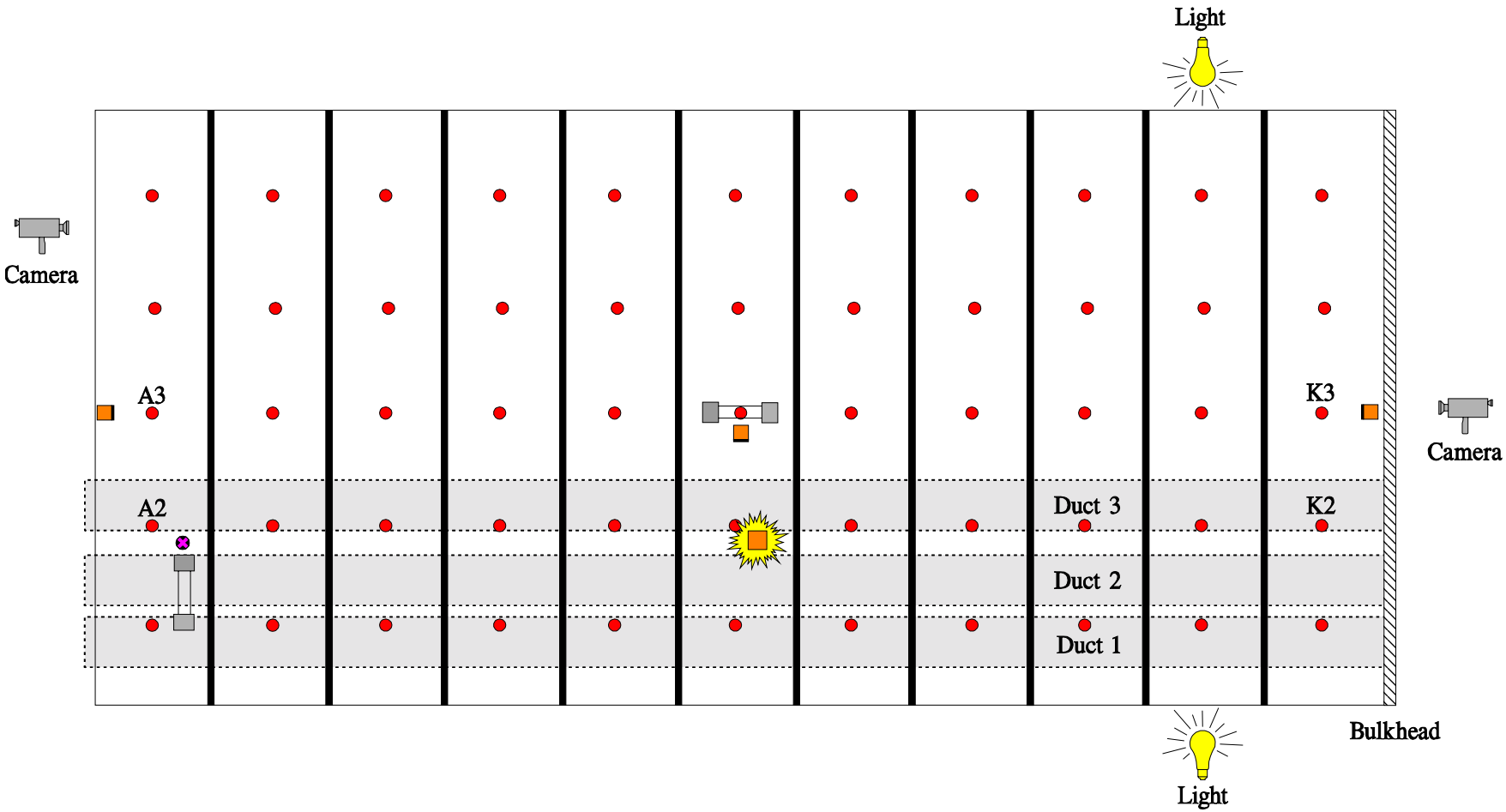

Intermediate Scale Testing
Relative Energy Release Rate
4" x 4" x 9" Urethane Foam Block
(4" x 4" x 18" Urethane Foam Block)
mPET ERR
PET3 ERR
PET00 ERR
PET1 ERR
FL POL ave ERR
PVF1-O ERR
PI-O ERR
Baseline ERR
Temperature (°F)
Time (seconds)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
60
120
180
240
300
360
420
480


OSU Test Results, Heat Flux=1.77W/cm2
Heat Peak Release (kW/m2)
35
30
25
20
15
10
5
0
4.8
6.17
6.39
6.5
11.26
13.41
14.7
17.8
25.03
33.02
PET00-O
PI-O
MPVF1-O
FL POL-C
MPVF2-F
PET1-F
PET1-O(W)
MPET1-F
PET3-F
PET1-O(R)

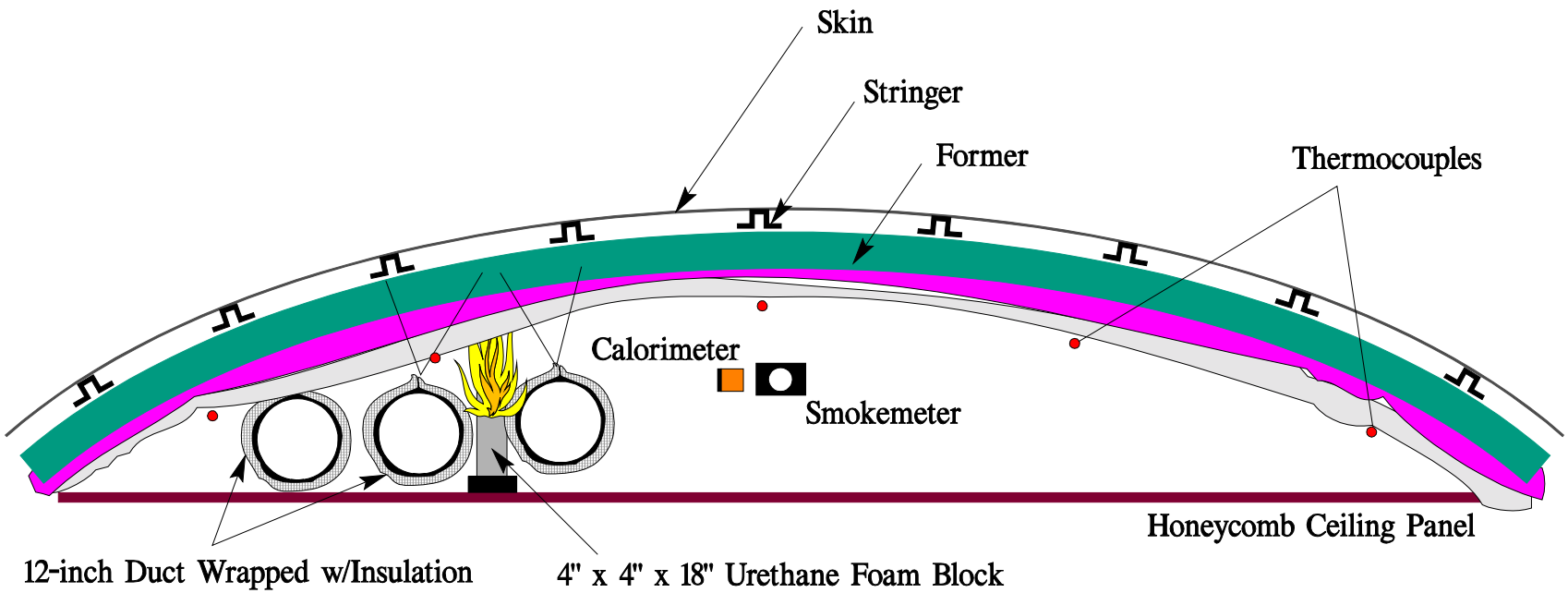
Radiant Panel Test Results: Percentage of Sample Burned



Full Scale Flame Propagation Tests in DC-10 Overhead



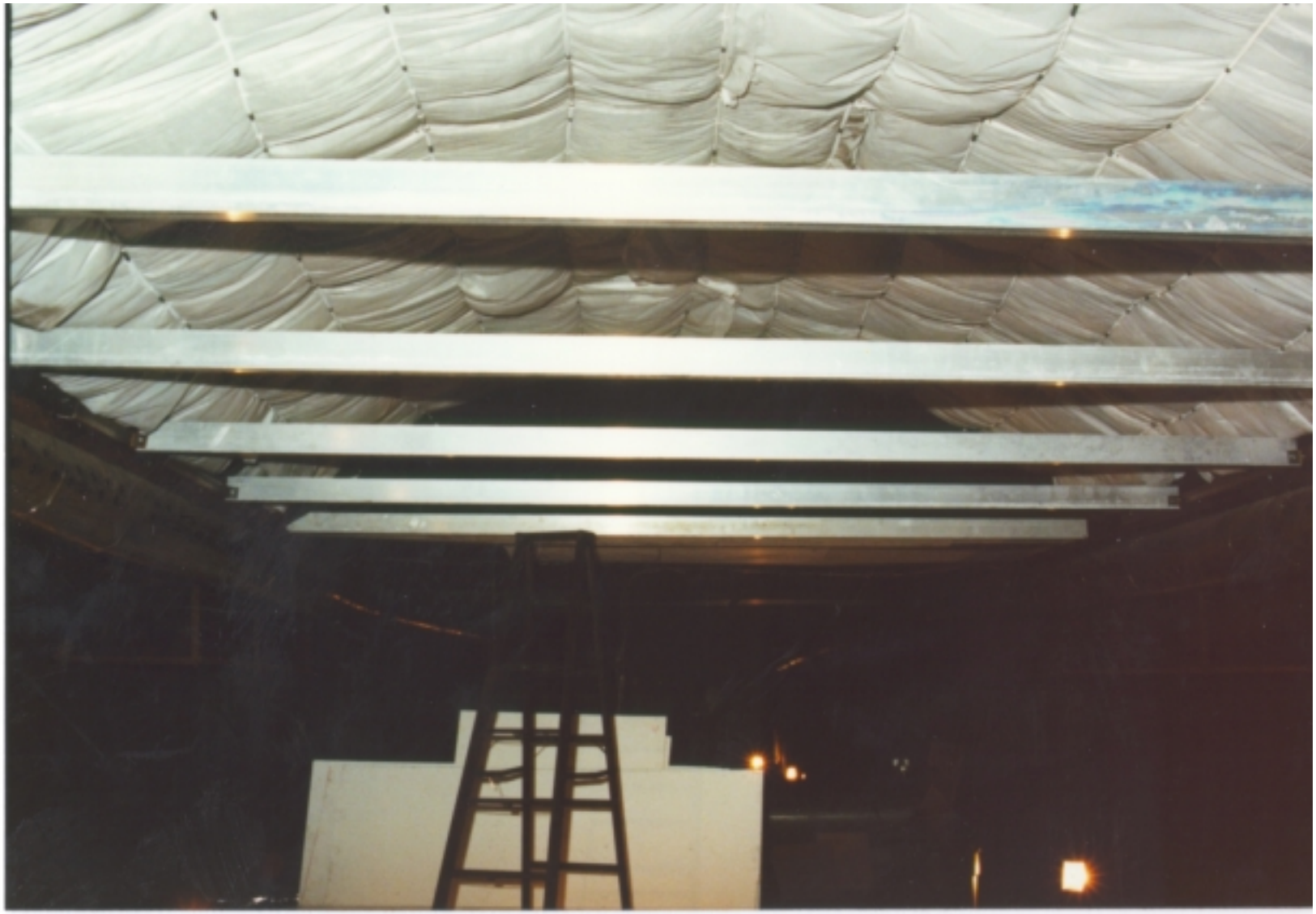
Full Scale Flame Propagation Test Arrangement in DC-10



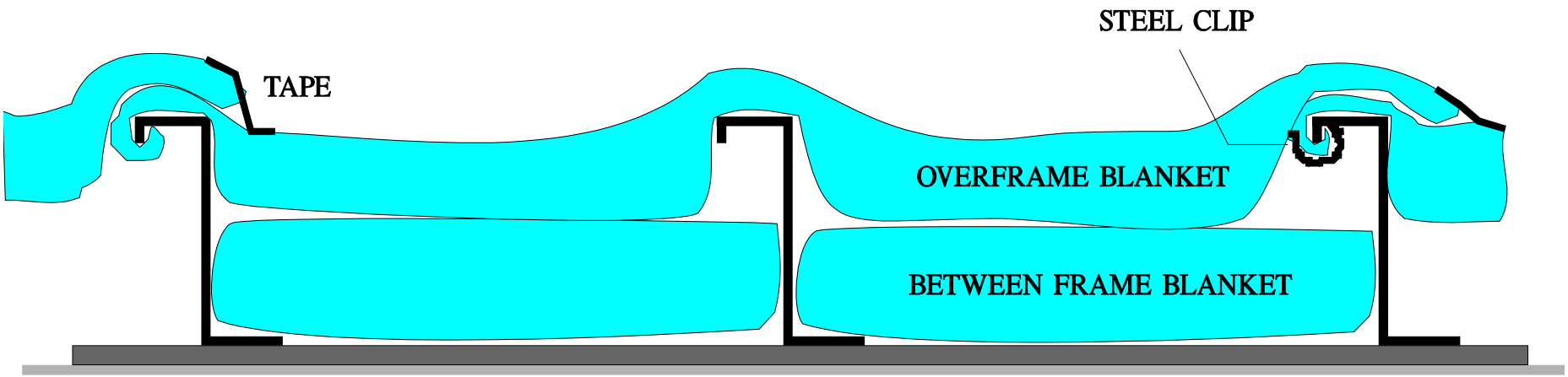
Between Frame Blanket

Over Frame Blanket

Class 1 PET-F



TWIN-JET UPPER DECK SIDEWALL INSULATION INSTALLATION



Class 1 PET-F, Thermocouple Installation

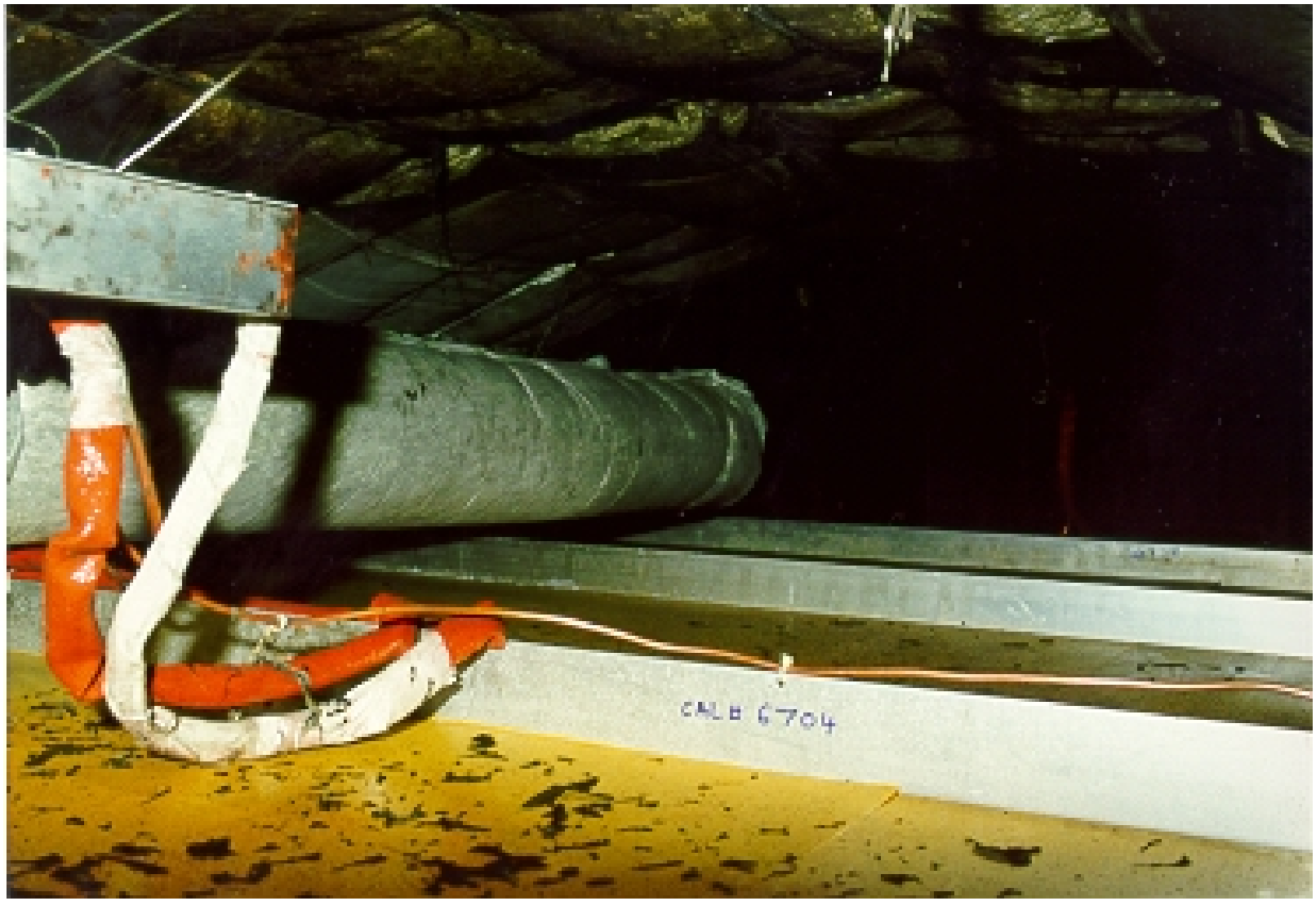
Class 1 PET-O, Arrangement of Ducts

Class 1PET-O, Flame Propagation on Duct

Class 1 PET-O, Flame Propagation on Duct

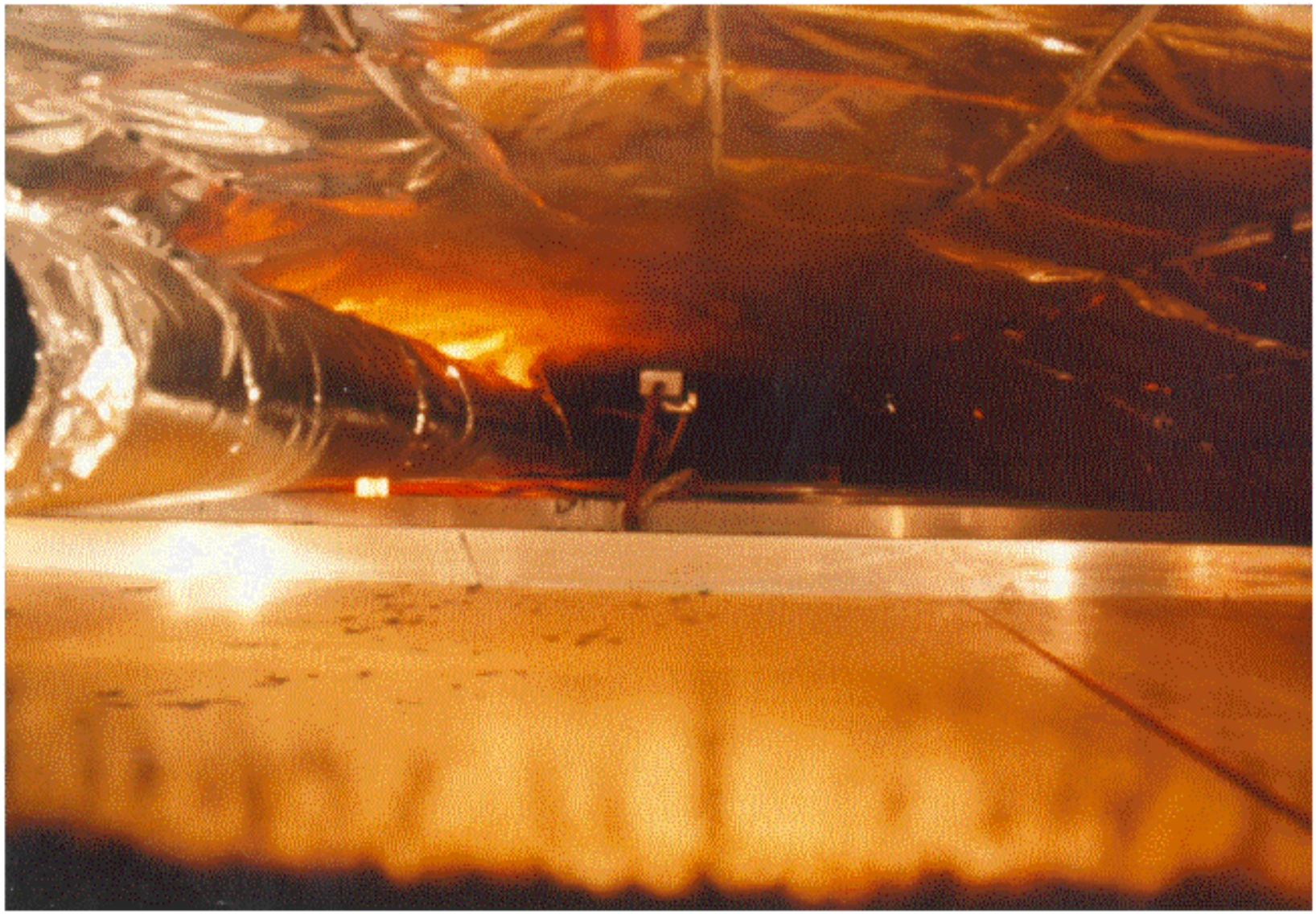
Class 1 PET-F, Arrangement of Ducts

Class 1 PET-O, Post Test Damage

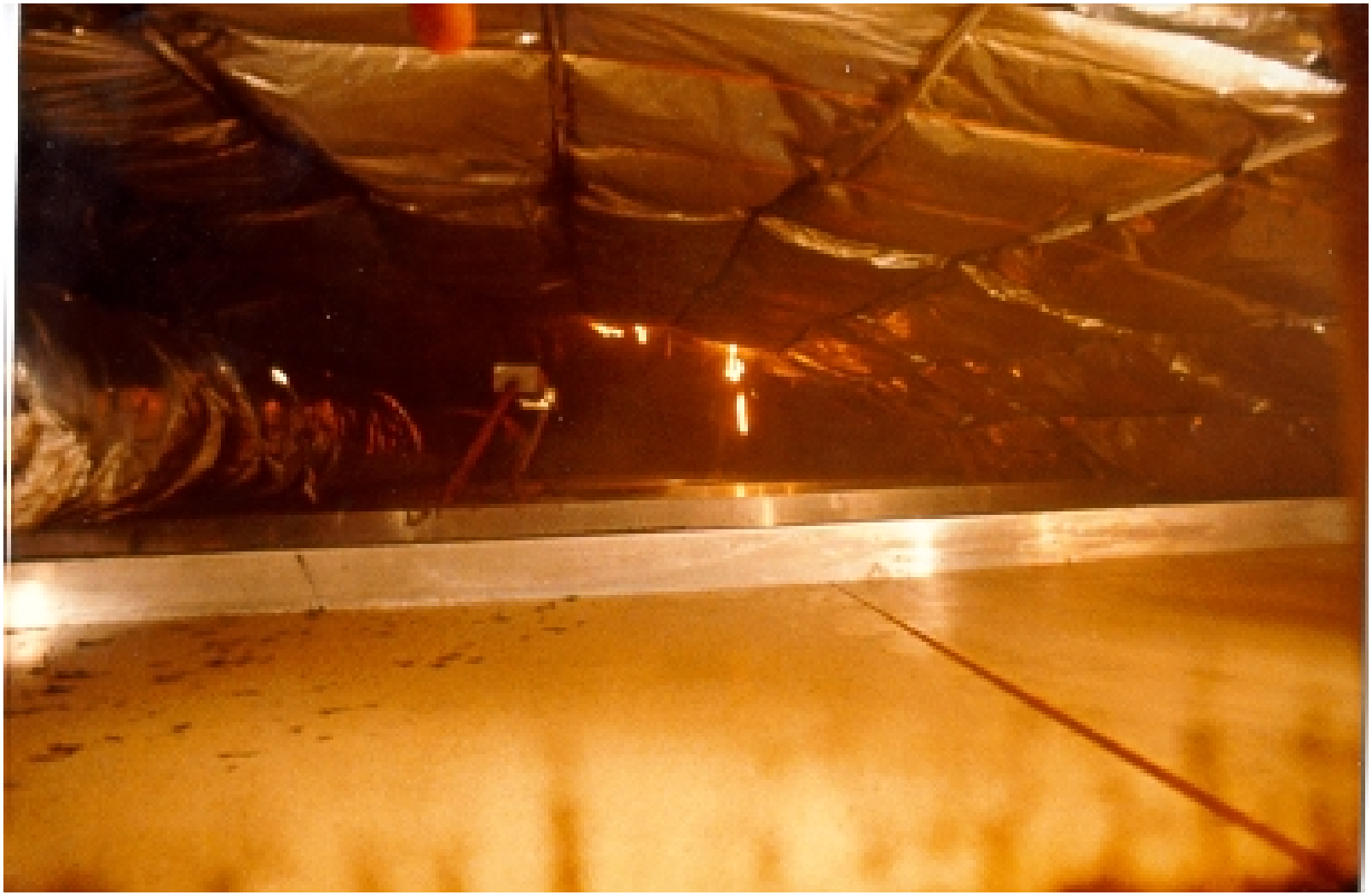


Metallized PET (2072L)

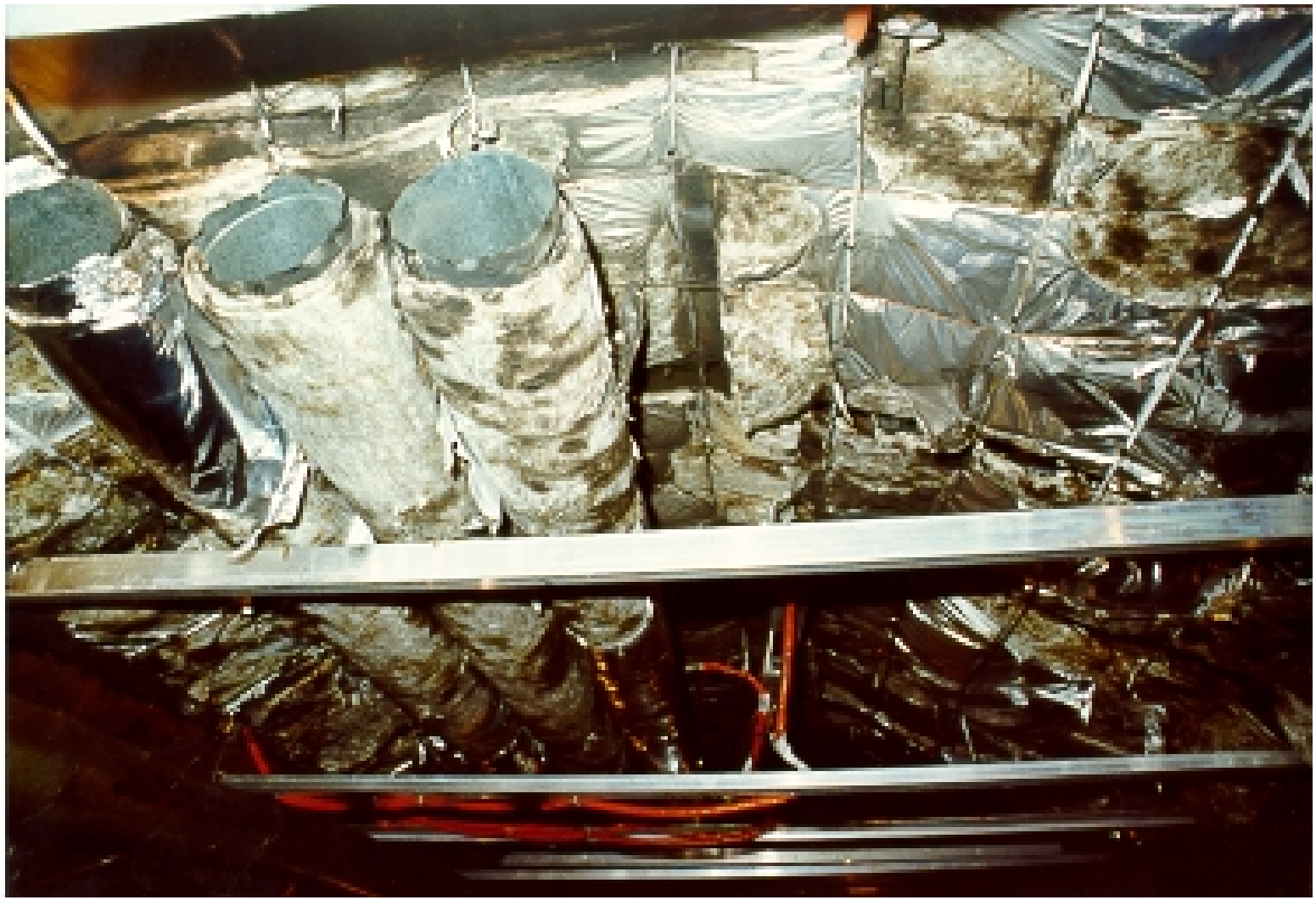
Metallized PET, Propagation Along Ducts



Metallized PET (2072L), Small Ignition Source



Metallized PET (2072L), Post Test Damage



Metallized PET (2072L), Post Test Damage

Metallized PET (2072L), Post Test Damage

Metallized PVF-O

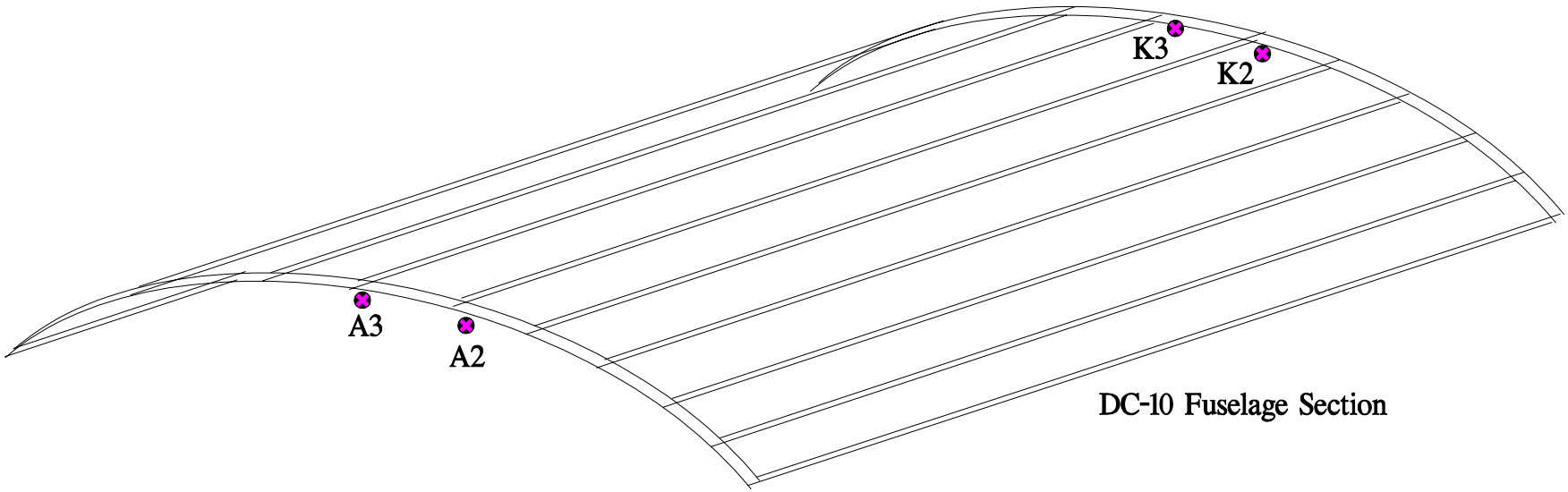
Metallized PVF-O, Propagation Along Ducts

Metallized PVF-O, Propagation Along Ducts

Metallized PVF-O, Post Test Damage

Metallized PVF-O, Post Test Damage

Energy Release Rate Determination



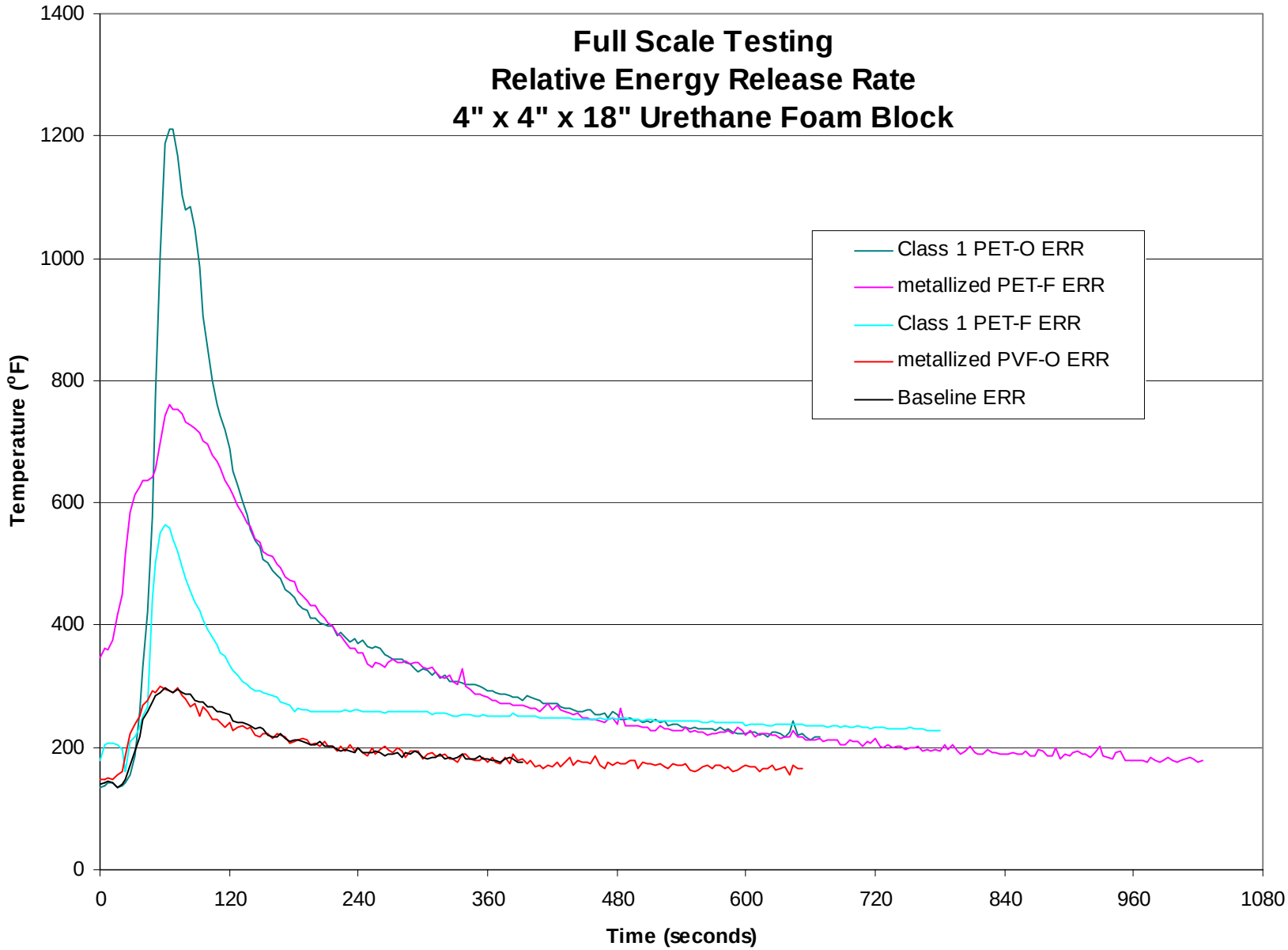
Thermocouple Location

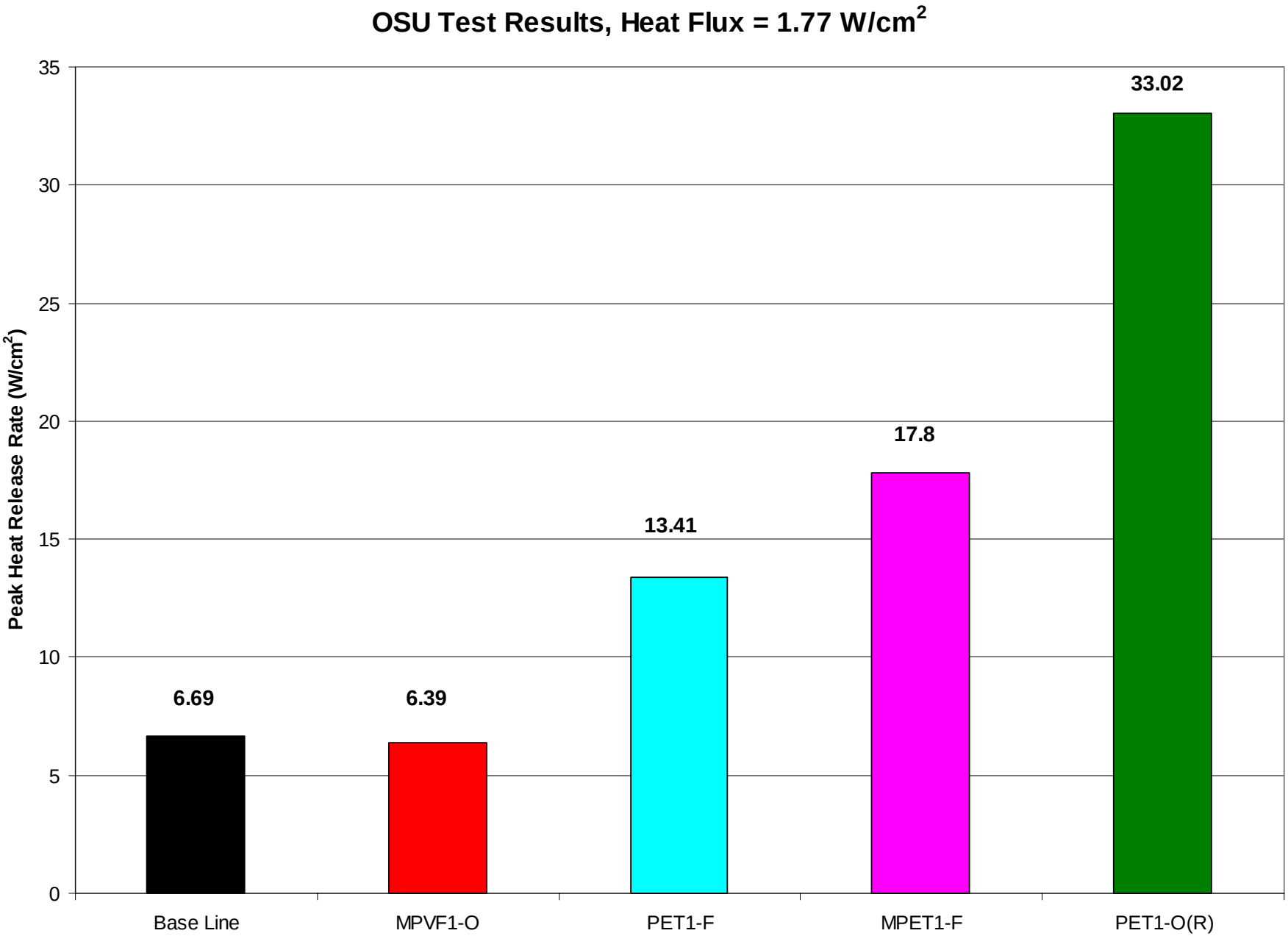
Energy Release Rate determined by:

Average of two thermocouples at each end, then the sum of the two end averages.

ERR = (A2+A3)/2 + (K2 + K3)/2

If the mass flow rates are equal at both ends, then this procedure gives an approximation to the Energy Release Rate.

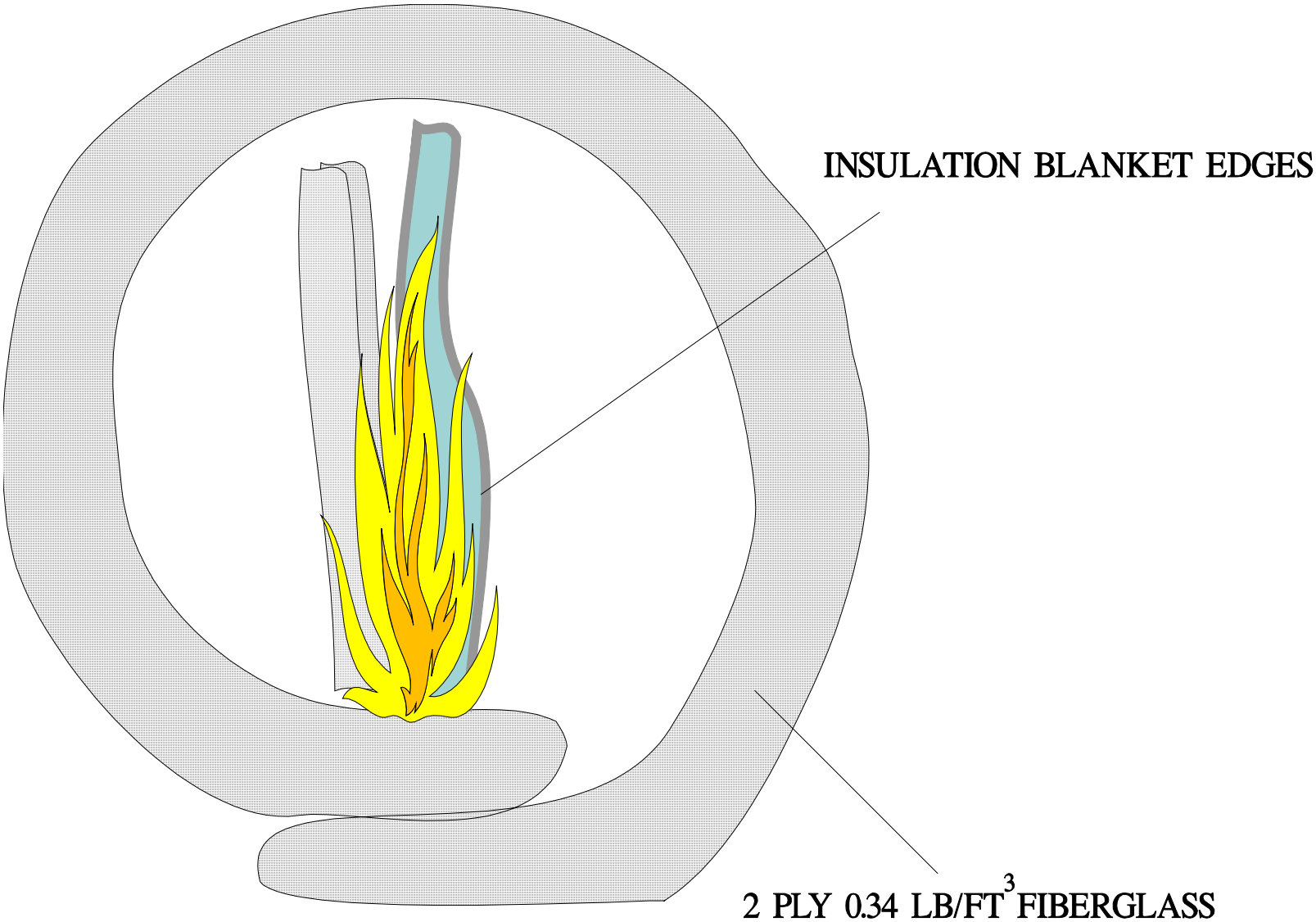

Full Scale Testing
Relative Energy Release Rate
4" x 4" x 18" Urethane Foam Block
Temperature (°F)
Time (seconds)
0
200
400
600
800
1000
1200
1400
0
120
240
360
480
600
720
840
960
1080
Class 1 PET-O ERR
metallized PET-F ERR
Class 1 PET-F ERR
metallized PVF-O ERR
Baseline ERR


OSU Test Results, Heat Flux = 1.77 W/cm2
Peak Heat Release Rate (W/cm2)
35
30
25
20
15
10
5
0
6.69
6.39
13.41
17.8
33.02
Base Line
MPVF1-O
PET1-F
MPET1-F
PET1-O(R)

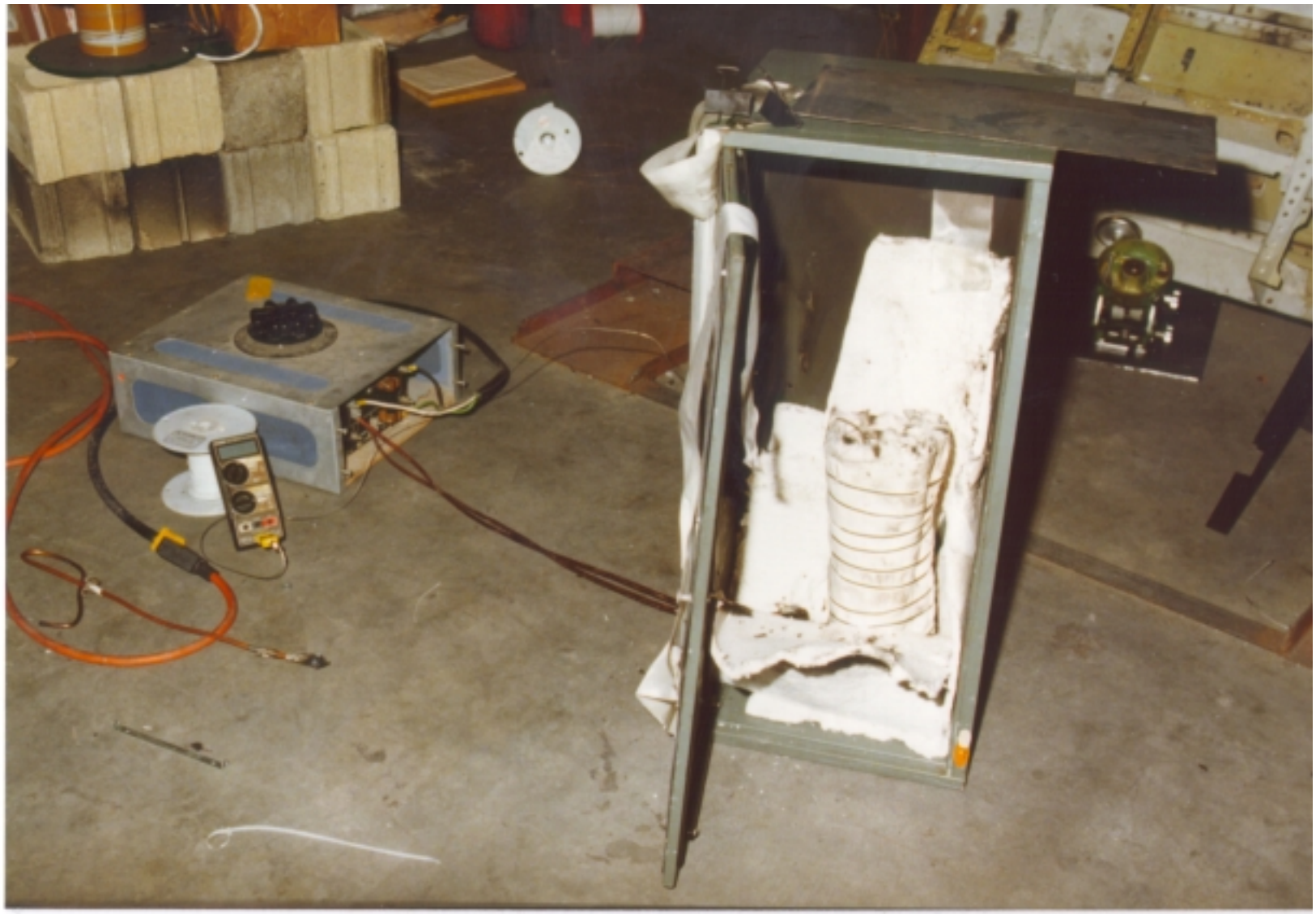
TUBULAR BLANKET TEST ARRANGEMENT

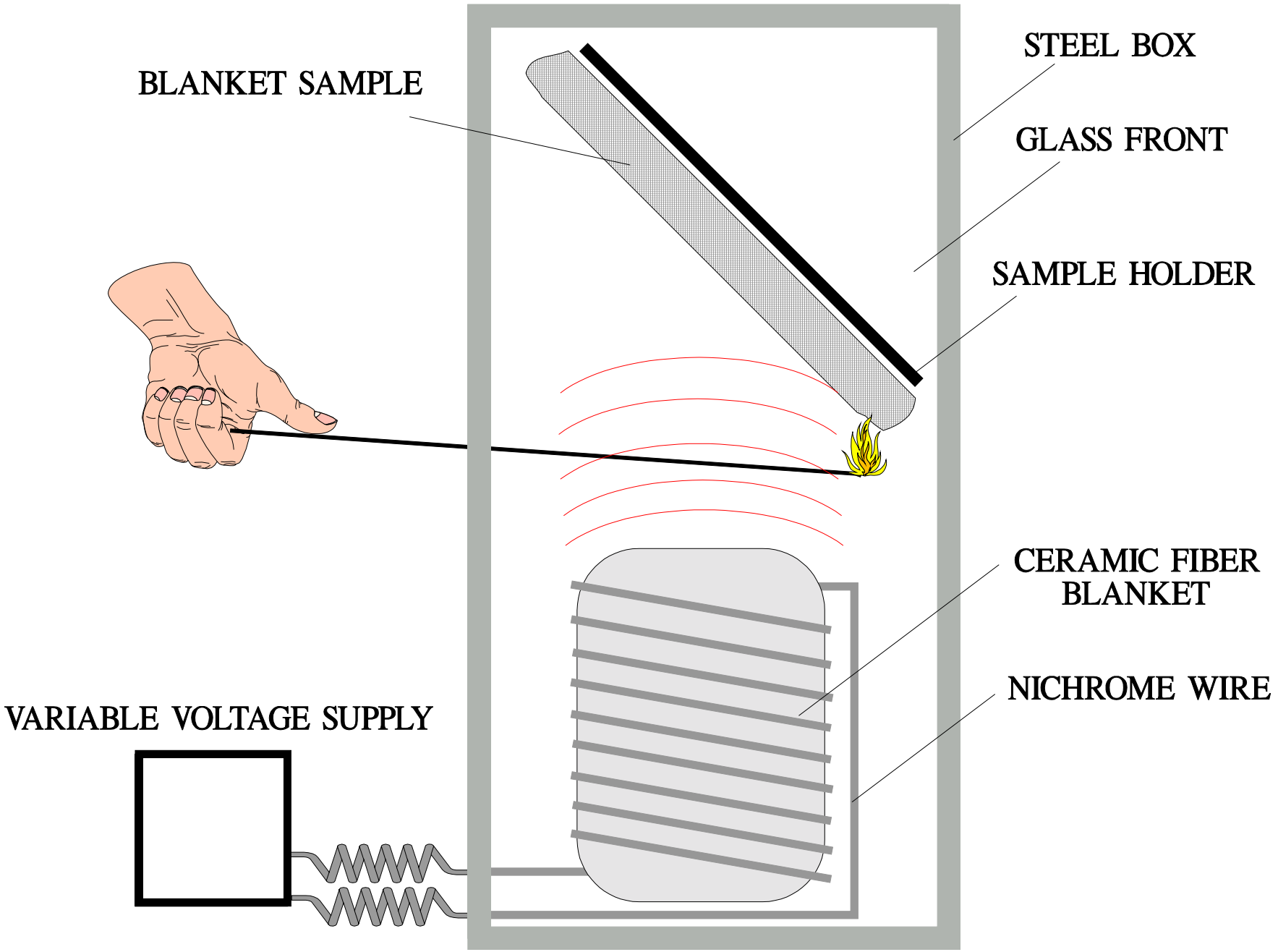
ROLLED INSULATION TEST

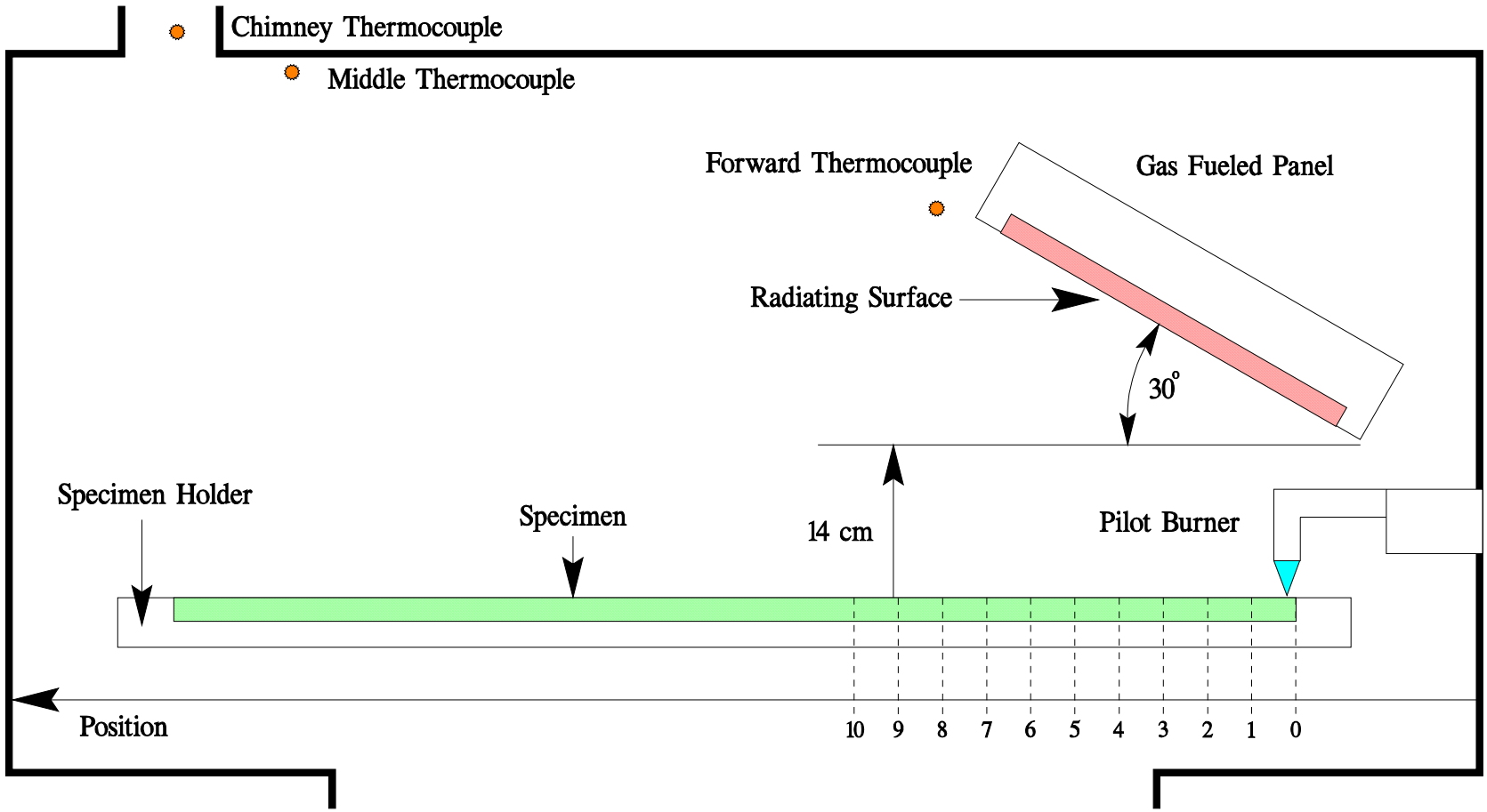
INSULATION TUBE TEST



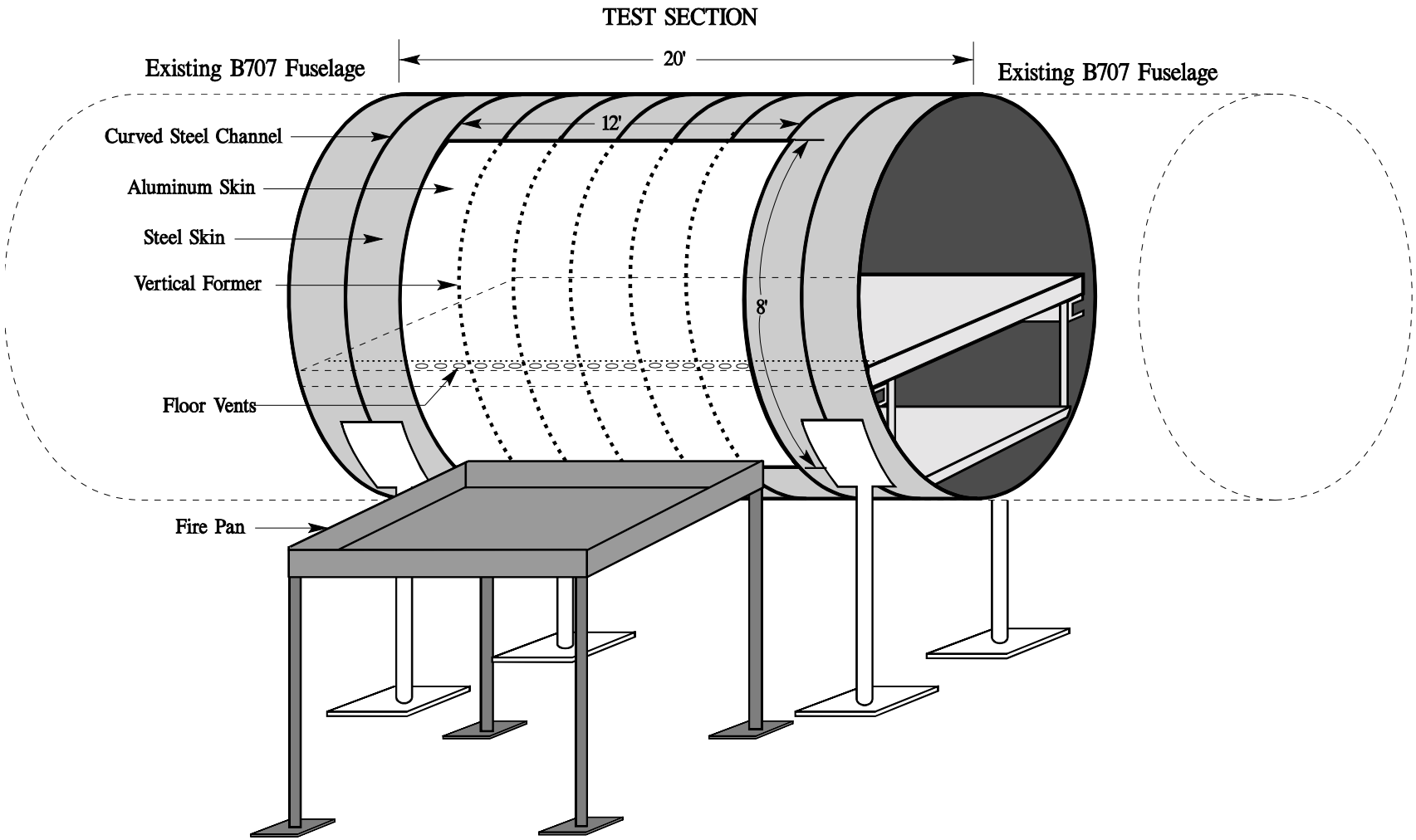
EFFECT OF PRE-HEATING FILM




BLANKET SAMPLE
STEEL BOX
GLASS FRONT
SAMPLE HOLDER
CERAMIC FIBER BLANKET
NICHROME WIRE
VARIABLE VOLTAGE SUPPLY


Chimney Thermocouple
Middle Thermocouple
Forward Thermocouple
Gas Fueled Panel
Radiating Surface
30°
Specimen Holder
Specimen
14 cm
Pilot Burner
Position
10 9 8 7 6 5 4 3 2 1 0

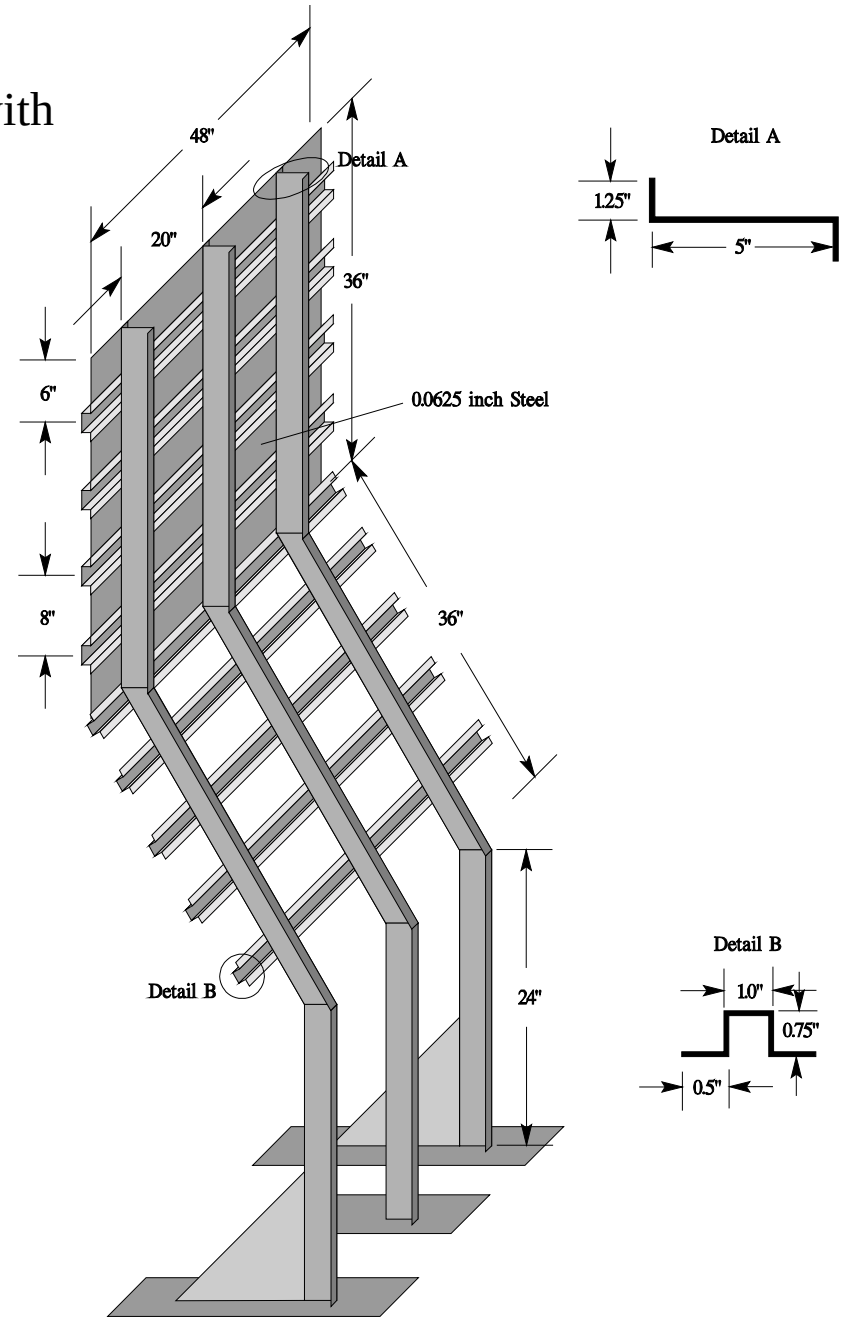
FULL-SCALE TEST RIG

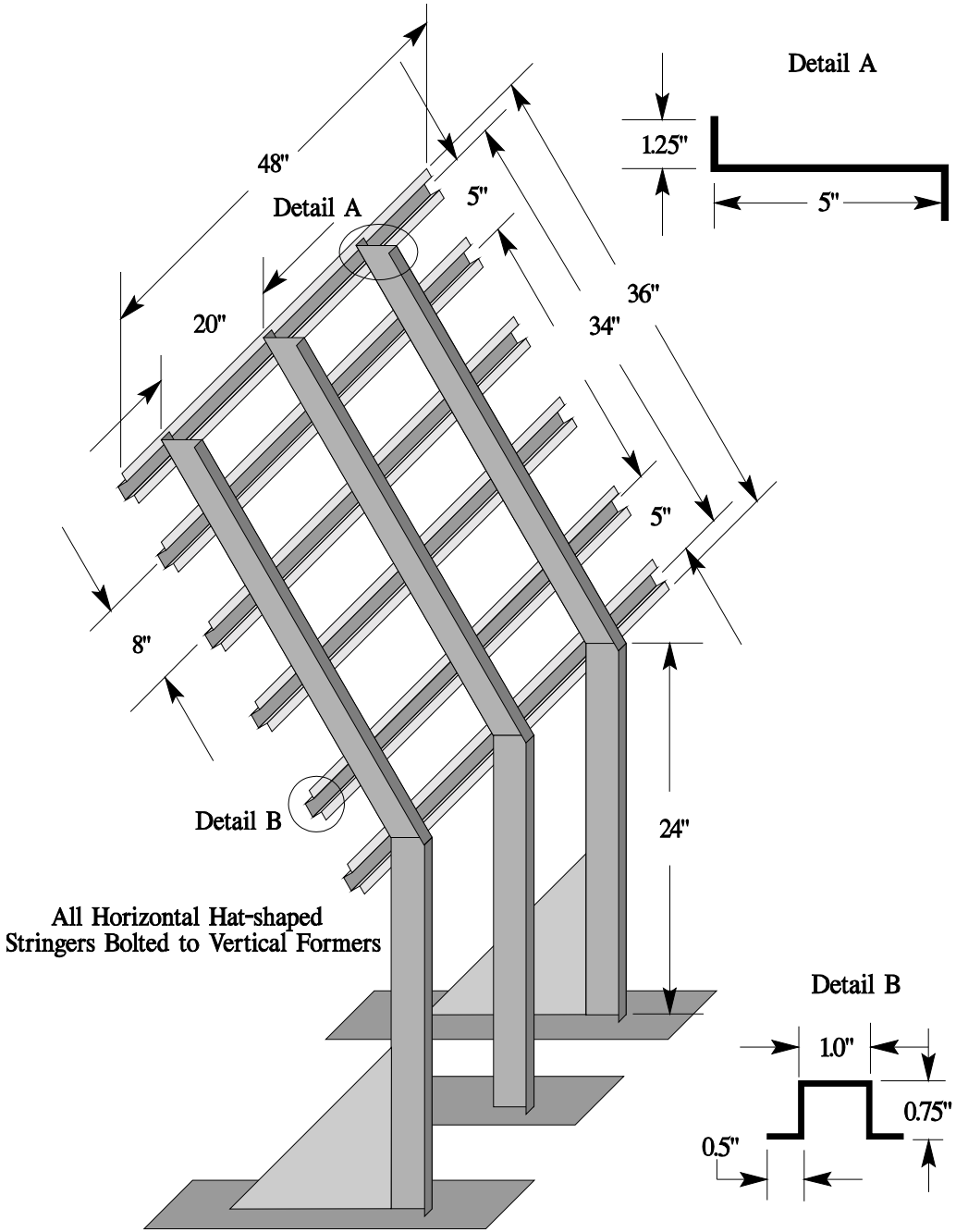


Aluminum Skin Testing

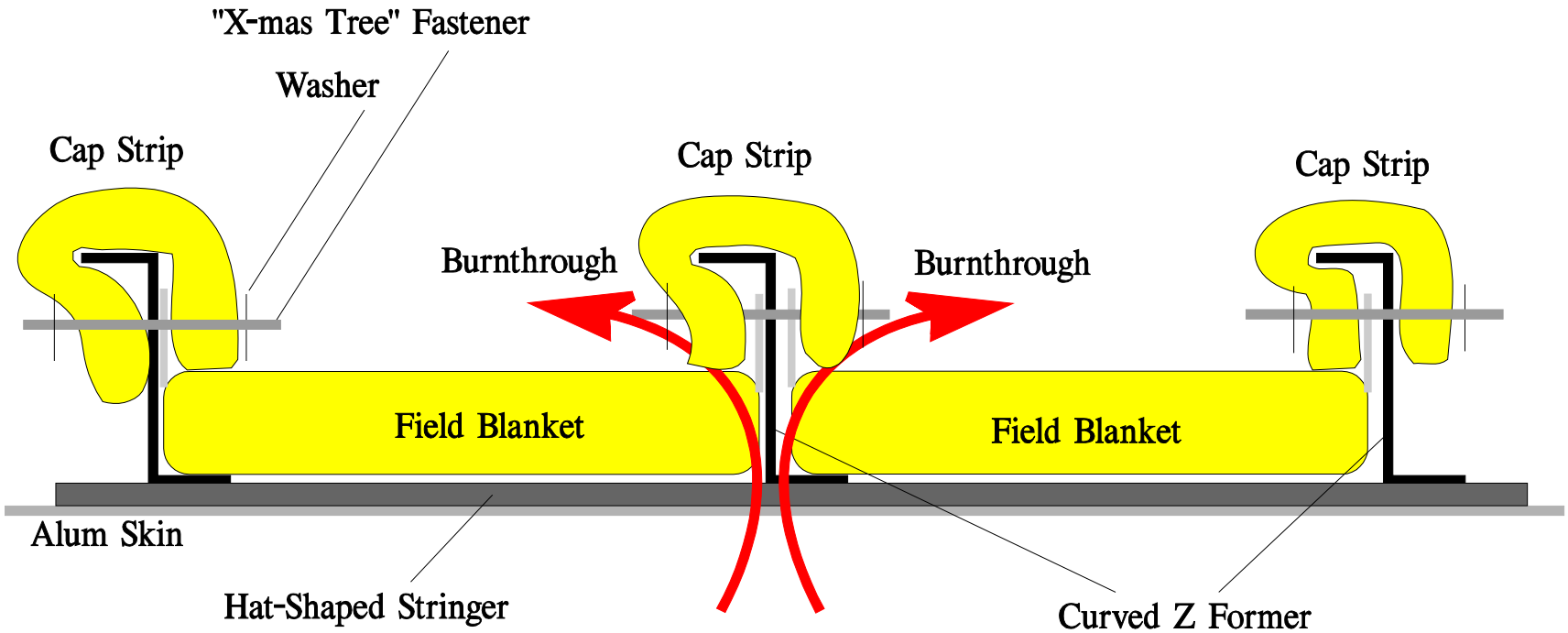
Second Generation
Curved Test Rig

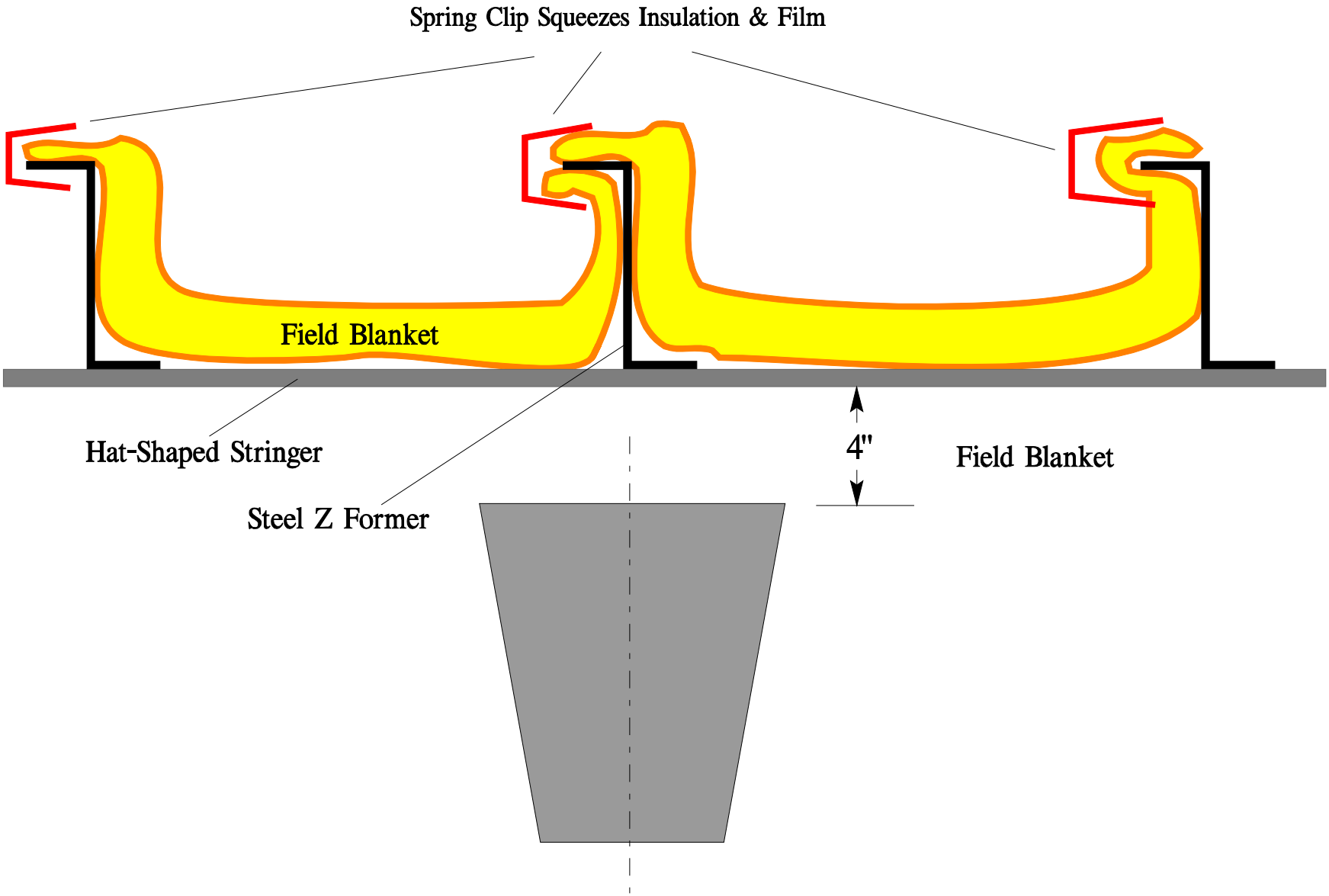
Third Generation Rig with No Skin

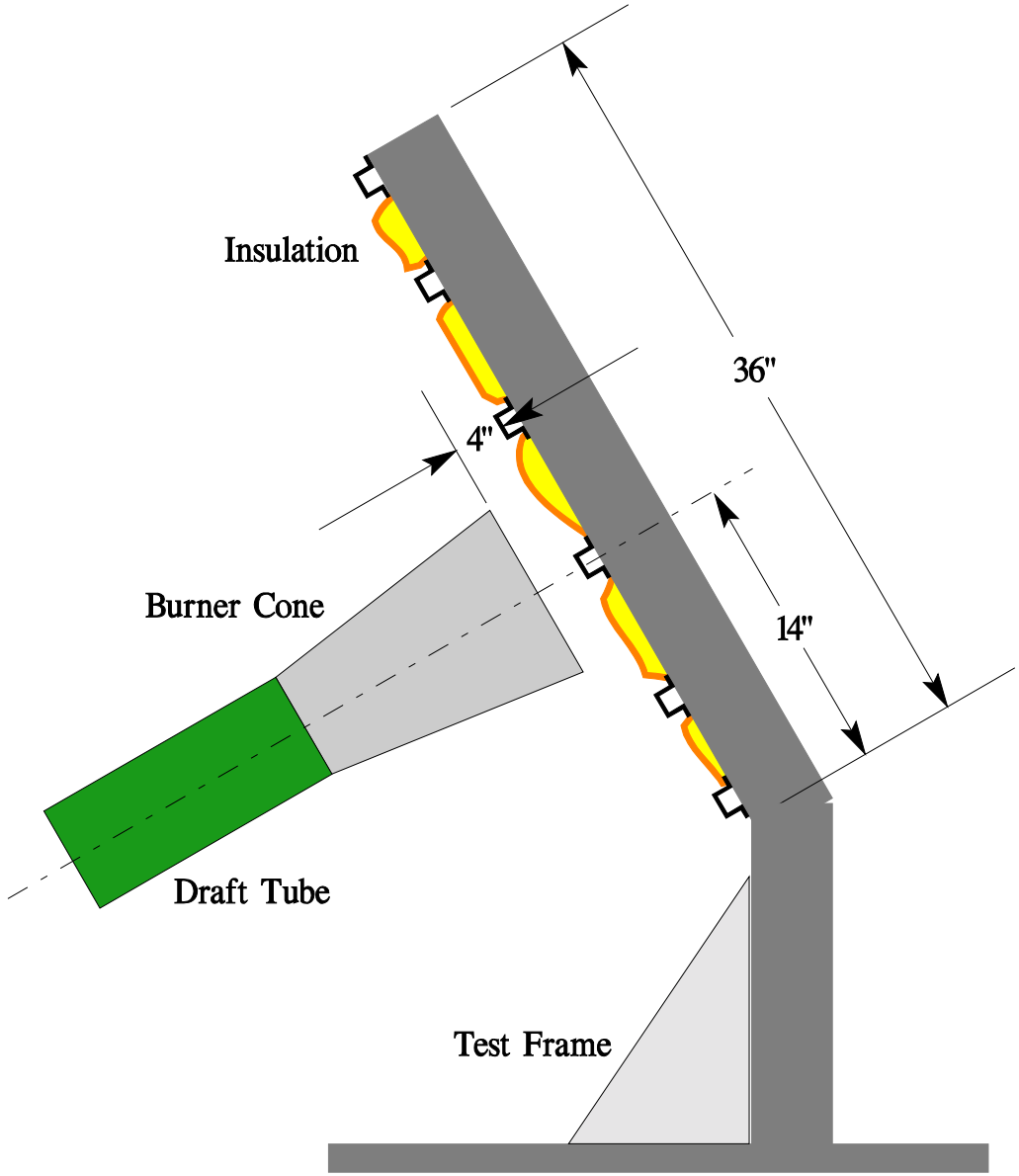




All Material 0.125-inch Thickness Except Center Vertical Former, 0.1875-inch Thick


"X-mas Tree" Fastener
Washer
Cap Strip
Cap Strip
Cap Strip
Burnthrough
Burnthrough
Field Blanket
Field Blanket
Alum Skin
Hat-Shaped Stringer
Curved Z Former


Spring Clip Squeezes Insulation & Film
Field Blanket
Hat-Shaped Stringer
Steel Z Former
4"
Field Blanket

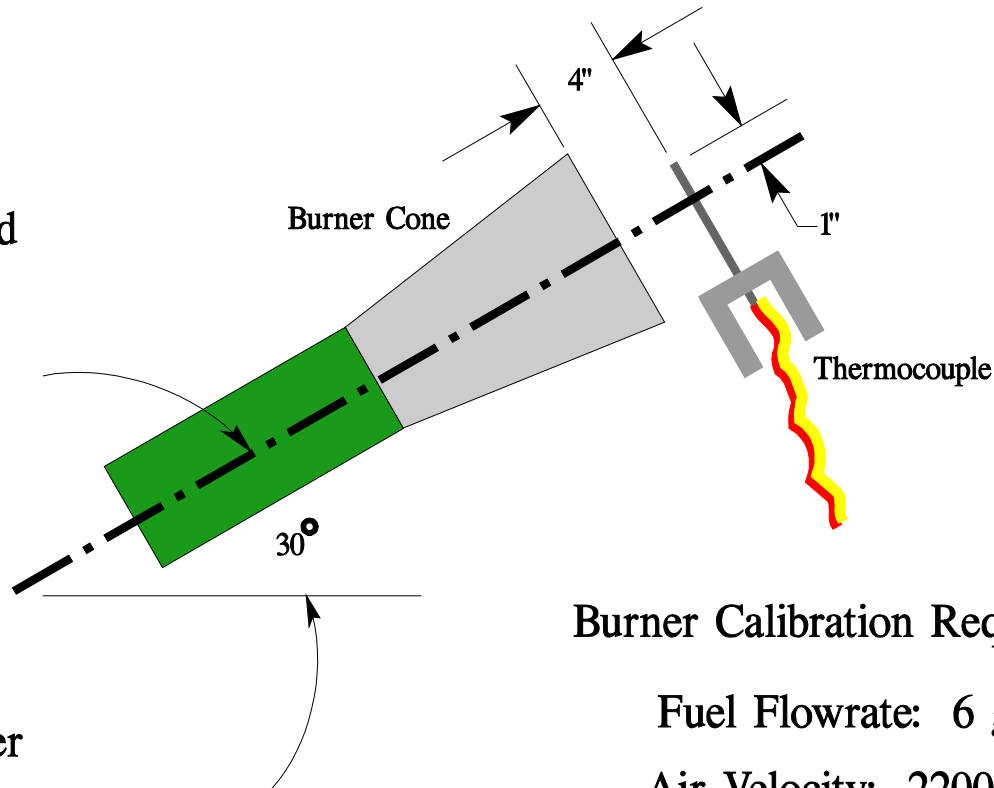

Insulation
36"
4"
14"
Burner Cone
Draft Tube
Test Frame

Burner Type
Park Model DPL 3400
(609) 344-7709

Nozzle Type
Monarch Manufacturing Co., Inc *
80°PLP (Semi-Solid)

Nozzle Type (alt)
Hago Manufacturing Co., Inc *
80°S.S. (Semi-Solid)
(908) 232-8687

Thermocouples
Thermo Electric Co., Inc *
Type K Grounded, 1/8"
Ceramic Packed, Metal Sheathed
(201) 843-5800



Air Velocity Meter
Omega Engineering, Inc *
Model HH30A
1-800-848-4286

Heat Flux Transducer
Vatell Corporation *
Model 1000 Series
(540) 961-2001

Burner Calibration Requirements

Fuel Flowrate: 6 gal/hr

Air Velocity: 2200 ft/min

Temperature: 2100 ± 100°F

Heat Flux: 13.5 ± 0.5 Btu/ft^2-sec

* website available

Typical Calibration Rig

Proposed Burnthrough Test Standard